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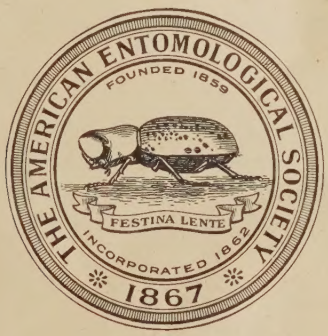

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TRANSACTIONS

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VOLUME LIII

A REMARKABLE NEW GENUS AND SPECIES OF DECTICID FROM LIBERTY COUNTY, FLORIDA (ORTHOPTERA, TETTIGONIIDAE)

BY MORGAN HEBARD

During the later part of the Summer of 1925, Mr. T. H. Hubbell camped for some time near the Appalachicola River, in Liberty County, western Florida. While there, a single specimen of a large green Decticid, having only slightly reduced organs of flight and a long, gently upcurved ovipositor, was secured. Though it has not been possible to find additional material, the insect is of so distinctive a phylum that the new genus and species which it represents can be easily characterized.

HUBBELLIA new genus

This genus is erected to include a single species, *H. praestans* here described. It is nearest *Pediodectes* Rehn and Hebard, though the female subgenital plate is more similar to the type developed in species of *Atlanticus* Scudder.

It agrees with *Pediodectes* as follows. Prosternum strongly bispinose. Lateral carinae of pronotal disk suggested only in metazonal portion and there very weak and broadly rounded. Caudal femora very elongate, much more than twice as long as pronotum, reaching well beyond apex of abdomen. Ovipositor elongate and weakly curved dorsad, its margins unarmed. Pronotum with dorsal outline straight in lateral aspect, no sellation indicated; lateral lobes longer than deep. Caudal tibiae with three pairs of apical spurs, the ventral pair therefore present. Size large. Plantula slightly longer than wide.

From *Pediodectes* we separate *Hubbellia* by the following features. Fastigium decidedly narrower, distinctly less than one-third as wide as the width between the eyes and showing a broad and shallow longitudinal impression disto-dorsad. Pronotum with metazonal portion of disk flattened and subglabrous (not as in *Pediodectes*, glabrous and smooth, often with faint longitudinal rugae; often showing a trace of tectation if a faint medio-longitudinal carina is indicated), its caudal margin distinctly truncate; humeral sinus of lateral lobes very faint, weaker than in *Pediodectes* and more dorsal in position. Mesosternal lobes bluntly spiniform produced. Tegmina and wings of female surpassing apex of abdomen, only moderately reduced (vestigial and wholly concealed by the pronotum in this sex of *Pediodectes*). Femora with genicular lobes all minutely unispinose and all ventral margins (except the caudal of the cephalic femora) armed with small spines. Cephalic tibiae with dorsal surface armed only externally with a distal and meso-distal spine; foramina rimate.

The genus might also be compared with the Californian *Cyrtophylleicus* Hebard which, however, differs in the smaller size, smaller eyes and much narrower fastigium which is strongly sulcate dorsad, flattened pronotal disk which expands more strongly caudad and has distinct lateral bounding carinae in over the caudal half, tegmina which are coriaceous, more reduced and broader,[1] vestigial wings, much shorter caudal femora, ventral margins of femora all armed, cephalic tibiae with dorso-external margin armed with four spines, caudal tibiae with ventral pair of spurs well separated (instead of adjacent) and plantula even shorter. These genera may very possibly be relicts of very ancient faunistic invasions.

The coloration of *Hubbellia* is distinctive; being in general green, with a broad median band of brown on head and pronotum which is weakly margined with yellowish, the tegmina having the discoidal vein and their margins also yellowish.

[1] The same sex can not be compared, as *Cyrtophylleicus* is known only from a male.

Hubbellia praestans new species (Pl. I)

It is surprising to find so large and distinctive an unknown species of the Orthoptera in the eastern United States.

Type: ♀; "Camp Torreya," Township 2 N–R 7 W, Liberty County, Florida. July 29, 1925. (T. H. Hubbell.) [Hebard Collection, Type No. 1087.]

Size large; form moderately stout, but more graceful than in *Pediodectes*. Fastigium about three-quarters as wide as first antennal joint. Surface smooth and shining, except metazona and dorsal portions of tegmina, which have more the appearance of ground glass. Sulci of pronotum with only the first well indicated. Tegmina tapering to the rather sharply rounded apices; ulnar vein branching proximad, humeral vein briefly separated from the discoidal, this slightly greater proximad where the former shows some convexity toward the costal margin; mediastine vein reaching two-fifths of length of costal margin and slightly heavier than the oblique costal veins. Ultimate tergite produced in two sharply acute-angulate processes with apices sharply rounded, on each side of the equilaterally triangular supra-anal plate, the dorsal surface of which is impressed. Ovipositor very elongate and gently curving dorsad to its acute apex, which is median in position. Subgenital plate large, proximad with coarse and very broadly rounded meso-lateral carinae, which curve to become parallel and then disappear before the strongly bilobate apex is reached. Limbs as described above.

General coloration light yellowish oil green. Dorsal surface of fastigium auburn, broadening and becoming blackish chestnut brown on occiput. Dorsal surface of pronotum with a moderately broad band of auburn obscurely margined with chalcedony yellow. Discoidal vein and margins of tegmina to near their apices chalcedony yellow. Ventro-external margin of caudal femora amber yellow. Margins of ovipositor buffy, the apex chestnut brown. All femoral spines with distal portions blackish brown.

Length of body 30.5, length of pronotum 8.3, caudal width of pronotal disk 4.7, length of tegmen 25.3, greatest tegminal width 6.7, length of ovipositor 31.3, length of cephalic femur 9.7, length of caudal femur 26 mm.

The type of this remarkable insect is unique. It was taken on a hot, humid night while collecting on the edge of a road bordering the Torreya ravine forest. The specimen was found on the top of a tall weed in the margin of the woods, while Mr. Hubbell was using an electric head light. His field notes state further that the green color and long ovipositor attracted attention at some distance and that the spot was directly beneath a large pine and near a clump of *Torreya* on the lip of the ravine. These ravine woods are composed of a heavy growth of beech and magnolia, with a few other species of trees; the shrub stratum consists of *Torreya*, *Rhaphidophyllum hystrix* (needle palm), a few *Taxus floridanus*, *Ostrya*, Red-Bud, *Cornus florida* a large-leaved Magnolia, abundant Holly, Witch-hazel and Wahoo. The ground is largely bare of herbage, the sandy soil covered with a thick layer of dead leaves and humus. As *Hubbellia praestans* was taken just above the margin of the woods, its true habitat is doubtful. Prolonged search on succeeding nights was unsuccessful, nor was any unusual song heard that might have been produced by males of the species.

HEBARD—A NEW DECTICID FROM FLORIDA

A PRELIMINARY STUDY OF THE GENITALIA OF FEMALE COLEOPTERA[1]

BY VASCO M. TANNER

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Introduction

The beetles are the largest and best known group of insects, with the possible exception of the Hymenoptera, and yet it is amazing how little is actually known about the comparative morphology of this order. This is largely due to the inadequate methods used in studying these elytroid forms. Students have been content, in most cases, to place these insects upon pins and treat them as priceless objects to be admired and not studied by means of microscopic dissection. As a result the morphological and systematic studies of the group have suffered.

Twenty thousand species of beetles are listed by Leng in his Catalogue of Coleoptera of America, North of Mexico and of this number it is safe to estimate that not more than one-fourth can positively be identified from the original descriptions. This seems to be a sweeping statement and a rather severe indictment

[1] Contribution from the Entomology Laboratories, Stanford University, California. June, 1925.

The Brigham Young University Research Council has provided funds to assist in publishing the plates of this paper.

to bring against the science of Coleopterology, but a careful study of conditions in this field seems to justify the conclusion.

This being the case there is need for an about face in the method of studying the beetles. More attention must be given to the morphological characters of a species when it is described and, if possible, drawings made of these structures.

It appears that the majority of students treat the taxonomic and morphological study of the insects as distinct unrelated studies, as well as ends in themselves. This is an inadequate point of view and one not up to the standards advocated by Leconte and Horn in their Classification of Coleoptera.

This point of view has been carried to an extreme by one of the foremost recent writers on the Coleoptera of the United States, the late Colonel Thos. L. Casey. Mr. Casey's apparent lack of appreciation of the value of morphological characters is shown in his last Memoir (1924). On page three of this publication he emphasizes the fact that many of his species of *Omus* are so unmistakably alike that their difference cannot be seen without placing them side by side; also that it is well-nigh impossible to describe these differences in words (the only way used by Colonel Casey) so they could be recognized when not in juxtaposition. It is interesting to note that of the 15,000 species of beetles in Colonel Casey's collection at the time of his death about 5,000 of these are represented by types (1925). If Colonel Casey, the describer of these species, could hardly figure out enough differences, in many cases, to write about, how can the student of the beetles in the future be expected to determine his material with these descriptions? About the only way would be to make comparisons with the specimens Casey used in making his descriptions and then it would even be doubtful.

It must be remembered that systematic studies have not as their purpose the giving of a definite name to each individual specimen, and yet, if the variable characters as color, size, slightly different angular curvature of the pronotum, and even geographic distribution, etc., are used as basic specific characters this will probably be the result. These characters should be used to supplement the morphological and physiological characters. By morphological characters I mean all the characters which are discernable in a relaxed insect, when studied under a

high power binocular microscope, and in most cases under a compound microscope. It is true that morphological characters are now used in specific descriptions, but only a fraction of the characters found on the insect's body are utilized.

Dr. J. Bequaert (1918), a leading student of Hymenoptera (wasps), has concluded that the morphological characters must supplement color and other variable characters. After studying the large collections of the National Museum, which have come from all parts of the world, Dr. Bequaert has become convinced that the chief characters for separating the species of this group must be sought in structure and sculpture, and that the color of the integument has scarcely any value for this purpose. This attitude and philosophy of Dr. Bequaert's in regard to species is just the antithesis of that held by Colonel Casey.

Dr. L. O. Howard recently (1925) suggested that we must have a broader and more thorough going group of systematic workers. Professor G. F. Ferris has also recently contributed to the Scientific Monthly an appeal for a different content in systematic work. The day seems to be fast passing when an insect can be given a name and then considered as known, and dismissed from further study. While names are indispensable starting points for biological work, yet the names in themselves have very little meaning. It is the giving of content to these names that concerns the systematist, and this is possible as a series of specimens of a species is studied and the variations of the characters noted. It is no doubt more important to bring together such information than to over estimate the value of an isolated type specimen.

It is because of our lack of knowledge of the comparative morphology of the beetles, and especially the female genital tract, that I undertook this study. Throughout this treatise I have constantly kept in mind and aimed to emphasize the following three points: (1) The need of a new method in the study of the beetles; (2) the addition to our knowledge of the morphology of the beetles, in this case the female genitalia; and finally (3) to make some deductions from this study that will add, in a general way, to the classification and phylogenetic understanding of the Coleoptera.

Acknowledgements

A problem of any consequence cannot be solved without the aid, suggestion and assistance of others. In view of this fact I take this opportunity of expressing my sincere appreciation and thanks to Professor G. F. Ferris, under whom this work has been carried on, for his many suggestions and criticisms; also for considerable mechanical help with the drawings and their arrangement in the plates. It would have been impossible to have accomplished portions of this treatise without the point of view and inspiration which is so characteristic of Professor Ferris.

I am greatly indebted to Dr. Frank E. Blaisdell of San Francisco, California, and wish to sincerely thank him for his wholehearted help in supplying material. He opened his rich collection of Coleoptera to me and gave freely of any species in it. Representatives of thirty families were received among which were such rare species as *Cupes concolor* West., *Hylecoetus lugubris* Say, and *Sphindus americanus* Lec., this latter species was collected by Hubbard and Schwarz.

I also extend my thanks to Mr. Carl D. Duncan of the State Teachers College, San Jose, California, for his contribution of material. Mr. Duncan generously turned over to me several hundred specimens of beetles which he had collected on both the Atlantic and Pacific Coasts. I am also indebted to Mr. Jos. C. Chamberlin of Riverside, California, for his cooperation in supplying several interesting species of Coccinellids.

Finally I wish to thank Mr. F. Muir of Honolulu, Hawaii, and Dr. G. C. Crampton of Amherst, Massachusetts for their suggestions in connection with the nomenclature and homologizing of the genital structure studies. At the beginning of this study I had the opportunity of discussing many of the problems of this paper with Mr. Muir who was then visiting in California. I have, through correspondence, gained much from Dr. Crampton and have followed, in the main his point of view as to the homoogies and nomenclature of the structures herein studied.

Methods

The methods used in this study are few and simple. All specimens were treated with hot caustic potash until sufficiently macerated for study, then washed in water for a few minutes and transferred to ninety-five per cent alcohol. Each specimen was dissected and studied while in alcohol then placed in a small spring clamp and a camera lucida drawing made. In some species the drawings of the ventral and lateral aspects do not agree as to the position of some of the structures. This is due to the specimen being shifted around after the ventral drawings were made and before the lateral ones were drawn.

Families and Species Studied

An effort has been made to study the genitalia of as many different families of beetles as possible. Leng in his catalogue recognized one hundred and nine families of beetles; of these a series of females from sixty-six families have been studied and many of them figured. Fully three-fourths of the species of Coleoptera are found within these families studied. The remaining one-fourth is distributed throughout a number of small or rare families.

In several families (Platypsyllidae, Leptinidae, Phengodidae, Georyssidae, Rhysodidae, Lyctidae, Pselaphidae, and Belidae) all the specimens available proved to be males. Such families as Telegeusidae, Derodontidae, Micromalthidae, Murmidiidae, Chelonaridae, Monoedidae, Eurystethidae, Rhizophagidae, Clambidae, Sphaeriidae, Sphaeritidae, Othniidae, and Cerophytidae because of their rareness were not at my disposal for study.

The figures have been numbered in consecutive order and in the following list each species is indicated by the numbers. The following list is arranged, in the main, according to Leng's catalogue and contains only the species figured in this dissertation:—

Suborder **ADEPHAGA**

Superfamily **CARABOIDEA**

CICINDELIDAE

COLLYRIRI *Collyris acrolia* Chaudoir (Figs. 1, 2)
Tricondyla cyanipes var. *planiceps* Schaum (Figs. 5, 6)

MEGACEPHALINI

OMINA	*Omus dejeani* Rche.	(Figs. 9, 10)
MEGACEPHALINA	*Tetracha carolina* (L.)	(Figs. 7, 8)

CICINDELINI

THERATINA	*Therates labiatus* Fab.	(Figs. 11, 12)
CICINDELINA	*Cicindela imperfecta* Lec.	(Figs. 3, 4, 199, 220)
	" *auduboni* Lec.	(Figs. 191, 222)
	" *graminea* Schp.	(Figs. 190, 215)
	" *cimarrona* Lec.	(Figs. 192, 211)
	" *hirticollis* Say	(Figs. 198, 207)
	" *tranquebarica* Hbst.	(Fig. 210)
	" *kirbyi* Lec.	(Figs. 195, 206)
	" *montana* Lec.	(Figs. 187, 212)
	" *laurenti* Schp.	(Figs. 188, 204)
	" *oregona* Lec.	(Fig. 208)
	" *maricopa* Leng	(Figs. 197, 214)
	" *echo* Csy.	(Figs. 193, 217)
	" *nigrocoerulea* Lec.	(Figs. 189, 221)
	" *chihuahuae* Bates	(Figs. 200, 205)
	" *lemniscata* Lec.	(Figs. 202, 209)
	" *praetextata* Lec.	(Figs. 201, 219)
	" Sp. ?	(Figs. 196, 218)
	" *arizonae* Wickh.	(Figs. 203, 216)
	" *obliquata* Dej.	(Figs. 194, 213)

CARABIDAE CARABINAE

CYCHRINI	*Brennus interruptus* (Men.)	(Figs. 13, 14)
CARABINI	*Calosoma tepidum* Lec.	(Figs. 19, 20)
SCARITINI	*Scarites californicus* Lec.	(Figs. 15, 16)

HARPALINAE

DRIPTINI	*Galerita lecontei* Dej.	(Fig. 21)
CHLAENIINI	*Chlaenius sericeus* Forst.	(Figs. 17, 18)
HARPALINI	*Harpalus pennsylvanicus* DeG.	(Figs. 24, 25)

AMPHIZOIDAE *Amphizoa insolens* Lec. (Figs. 22, 23)

OMOPHRONIDAE *Omophron dentatum* Lec. (Figs. 26, 27)

HALIPLIDAE *Peltodytes simples* (Lec.) (Figs. 28, 29)

DYTISCIDAE LACCOPHILINAE

LACCOPHILINI *Laccophilus maculosus* (Germ.) (Figs. 30, 31)

Superfamily **GYRINOIDEA**

GYRINIDAE

GYRININI *Gyrinus consobrinus* Lec. (Figs. 32, 33)

Suborder POLYHAGA

Superfamily **HYDROPHILOIDEA**

HYDROPHILIDAE HYDROPHILINAE
HYDROPHILINI *Hydrous triangularis* (Say) (Figs. 34, 35)

Superfamily **SILPHOIDEA**

BRATHINIDAE *Brathinus californicus* Hub. (Figs. 44, 45)

SILPHIDAE
SILPHINI *Silpha lapponica* Hbst. (Figs. 40, 41)
Silpha americana L. (Figs. 38, 39)

Superfamily **STAPHYLINOIDEA**

STAPHYLINIDAE STAPHYLININAE
STAPHYLININI *Creophilus villosus* (Grav.) (Figs. 36, 37)

SCAPHIDIIDAE *Scaphidium 4-guttatum* Say (Figs. 42, 43)

HISTERIDAE *Hister semiruber* Csy. (Figs. 46, 47)

Superfamily **CANTHAROIDEA**

LYCIDAE *Calopteron reticulatum* (Fab.) (Figs. 52, 53)

LAMPYRIDAE *Lucidota californica* (Mots) (Figs. 50, 51)

CANTHARIDAE
CANTHARINI *Podabrus* Sp.? (Figs. 48, 49)

MELYRIDAE
MALACHIINAE *Collops marginellus* Lec. (Figs. 54, 55)

CLERIDAE CLERINAE
TILLINI *Cymatodera brunnea* Spin. (Figs. 56, 57)

CORYNETIDAE
CORYNETINI *Necrobia rufipes* (DeG.) (Figs. 58, 59)

Superfamily **LYMEXYLOIDEA**

LYMEXYLIDAE *Hylecoetus lugubris* Say (Figs. 60, 61)

Superfamily **CUPESOIDEA**

CUPESIDAE *Cupes concolor* Westw. (Figs. 62, 63)

Superfamily **MORDELLOIDEA**

OEDEMERIDAE
ASCLERINI *Copidita quadrimaculata* (Mots.) (Figs. 80, 81)

MORDELLIDAE
MORDELLINI *Mordella grandis* Lilj. (Figs. 64, 65)

MELOIDAE MELOINAE
LYTTINI *Lytta cooperi* Lec. (Figs. 66, 67)

PYTHIDAE *Pytho strictus* Lec. (Figs. 68, 69)

PEDILIDAE
PEDILINI *Pedilus flavidus* Fall (Figs. 72, 73)

ANTHICIDAE *Anthicus alacer* Csy. (Figs. 70, 71)

Superfamily **ELATEROIDEA**

ELATERIDAE ELATERINAE
MELANOTINI *Melanotus communis* (Gyll.) (Figs. 84, 85)

CEBRIONIDAE *Cebrio mandibularis* (Lec.) (Figs. 78, 79)

PLASTOCERIDAE *Euthysanius pretiosus* Lec. (Figs. 76, 77)

RHIPICERIDAE *Sandalus niger* Knoch (Figs. 74, 75)

MELASIDAE
EUCNEMINI *Dromaeolus nitens* Horn (Figs. 82, 83)

BUPRESTIDAE
CHRYSOBOTHRINI *Chrysobothris debilis* Lec. (Figs. 91, 92)

Superfamily **DRYOPOIDEA**

DRYOPIDAE
DRYOPINI *Helichus productus* Lec. (Figs. 86, 87, 88)

Superfamily **DASCILLOIDEA**

DASCILLIDAE *Macropogon testaceipennis* Mots. (Figs. 95, 96)

EUCINETIDAE *Eucinetus infumatus* Lec. (Figs. 89, 90)

HELODIDAE
HELODINAE *Cyphon concinnus* (Lec.) (Figs. 93, 94)

Superfamily **BYRRHOIDEA**

DERMESTIDAE DERMESTINAE
DERMESTINI *Dermestes vulpinus* Fab. (Figs. 97, 98)

BYRRHIDAE AMPHICYRTINAE
AMPHICYRTINI *Amphicyrta dentipes* Er. (Figs. 99, 100)

Superfamily **CUCUJOIDEA**

OSTOMIDAE
TENEBROIDINI *Temnochila chlorodia* (Mann). (Figs. 103, 104)

NITIDULIDAE CRYPTARCHINAE
IPINI *Glischrochilus cylindricus* (Lec.) (Figs. 101, 102)

MONOTOMIDAE
MONOTOMINAE *Leptipsius striatus* (Lec.) (Figs. 105, 106)

CUCUJIDAE
CUCUJINI *Cucujus clavipes* Fab. (Figs. 111, 112)

EROTYLIDAE EROTYLINAE
DACNINI *Megalodacne fasciata* (Fab.) (Figs. 107, 108)

COLYDIIDAE
SYNCHITINI *Coxelus pacificus* Horn (Figs. 109, 110)

ENDOMYCHIDAE ENDOMYCHINAE
LYCOPERDININI *Aphorista laeta* (Lec.) (Figs. 113, 114)

PHALACRIDAE *Phalacrus ovalis* Lec. (Figs. 115, 116)

COCCINELLIDAE COCCINELLINAE
HYPERASPINI *Brachyacantha socialis* Csy. (Figs. 119, 120)
COCCINELLINI *Hippodamia complex* Csy. (Figs. 117, 118)
CHILOCORINI *Chilocorus bivulnerus* Muls. (Figs. 121, 122)
EPILACHNINAE *Epilachna corrupta* Muls. (Figs. 123, 124)

Superfamily **TENEBRIONOIDEA**

ALLECULIDAE
ALLECULINAE *Hymenorus prolixus* Csy. (Figs. 127, 128)

TENEBRIONIDAE TENEBRIONINAE
ELEODINI *Eleodes dentipes* Esch. (Figs. 129, 130)
Eleodes lucae Lec. (Figs. 125, 126)
Eleodes nevadensis Blais. (Figs. 131, 132)

TENTYRIINAE
NOSODERMINI *Phloeodes diabolicus* Lec. (Figs. 133,134)

CONIONTINAE
CONIONTINI *Coniontis opaca* Horn (Figs. 135, 136)

TENEBRIONINAE *Coelocnemis sulcata* Csy. (Figs. 137, 138)

LAGRIIDAE
LAGRIINI *Arthromacra aenea* (Say) (Figs. 139, 140)

MONOMMIDAE *Hyporhagus gilensis* Horn (Figs. 141, 142)

MELANDRYIDAE
MELANDRYINI *Melandrya striata* Say (Figs. 143, 144)

Superfamily **BOSTRICHOIDEA**

ANOBIIDAE
ANOBIINI *Trichodesma gibbosa* (Say) (Figs. 145, 146)

BOSTRICHIDAE
PSOINI *Polycaon stouti* (Lec.) (Figs. 147, 148)

SPHINDIDAE *Sphindus americanus* Lec. (Figs. 151, 152)

CISIDAE CISINAE *Cis ursulina* Csy. (Figs. 149, 150)

Superfamily **SCARABAEOIDEA**

SCARABAEIDAE RUTELINAE
RUTELINI *Pelidnota punctata* (L.) (Figs. 155, 156)

CETONIINAE
CETONIINI *Euphoria rufobrunnea* Csy. (Figs. 157, 158)

TROGIDAE *Trox scabrosus* Beauv. (Figs. 159, 160)

LUCANIDAE
LUCANINAE *Pseudolucanus mazama* (Lec.) (Figs. 161, 162)
SINODENDRINAE *Sinodendron rugosum* Mann. (Figs. 153, 154)

PASSALIDAE *Passalus cornutus* Fab. (Figs. 163, 164)

Superfamily **CERAMBYCOIDEA**

CERAMBYCIDAE PRIONINAE
PRIONINI *Prionus californicus* Mots. (Figs. 167, 168)

CERAMBYCINAE
LEPTURINI *Rhagium lineatum* Oliv. (Figs. 165, 166)

CHRYSOMELIDAE EUMOLPINAE
MYOCHROINI *Glyptoscelis squamulata* Cr. (Figs. 169, 170)
CORYNODINI *Chrysochus cobaltinus* Lec. (Figs. 171, 172)

HISPINAE CHALEPINI *Baliosus ruber* (Web.) (Figs. 173, 174)

MYLABRIDAE *Mylabris obtectus* Say (Figs. 175, 176)

Superfamily **BRENTOIDEA**

BRENTIDAE *Brentus anchorago* (L.) (Figs. 177, 178)

Superfamily **CURCULIONOIDEA**

CURCULIONIDAE RHYNCHITINAE
RHYNCHITINI *Rhynchites bicolor* Fab. (Figs. 181, 182)

OTIORHYNCHINAE
EPICAERINI *Pantomorus fulleri* (Horn) (Figs. 179, 180)

CURCULIONINAE
ERIRHININI *Dorytomus laticollis* Lec. (Figs. 183, 184)

CALENDRINAE
SPHENOPHORINI *Rhodobaenus tredecimpunctatus* (Ill.) (Figs. 185, 186)

THE LITERATURE

A sifting of the voluminous insect literature reveals only a few important papers on this subject. The most outstanding of these was written by Dr. F. Stein (1847) of Berlin. Considering that this work was produced under the conditions existing seventy-five years ago it is a very creditable contribution. Dr. Stein devoted considerable time and space to the discussion and illustration of the internal sex organs and glands. He concluded that there are but nine abdominal segments in the female beetle and he designated the following structures, stylus, coxite, and valvifer as the "vaginalpalpe." This is an inadequate point of view for the present since there are a number of sclerites and they should not be treated as one structure. Stein's phylogenetic conclusions, the results of his study of the abdomen, ovaries, and genitalia, divided the then known and recognized families into twenty-four groups or what is now called superfamilies. He made drawings of about twenty-five families. These drawings were lithographed and are not equaled by the great majority of scientific illustrations of today.

Dr. C. Verhoeff made the next contributions to our knowledge of this subject. He published in 1893, 1894, and 1918 papers dealing with the abdomen and genitalia of female beetles. I cannot agree with his interpretation of the genital structures. The segments I have considered the paraproct, valvifer, and coxite he designated as the ninth tergite or sternite. He thinks the stylus is a secondary abdominal structure. I have pointed out in the following chapter that the stylus, coxite, and valvifer are considered as primary abdominal appendages. Verhoeff's figures are poor and in some cases misleading. Dr. Heymons (1899) who has done considerable work on the genitalia of insects, in general, expressed the belief in 1899 that there was little support for Verhoeff's opinions and conclusions.

Peytoureau's (1895) contribution to the morphology of the genital armature of insects in 1895 did not advance the knowledge of the coleopterous structures much. He failed to homologize the structures found in the beetles he studied and was mislead as to the segmentation and interpretation of the structure of the genital tube.

Wandolleck's (1905) paper, Comparative Morphology of the Abdomen of Female Beetles, is a valuable and well prepared discussion of the six families (Cerambycidae, Elateridae, Buprestidae, Chrysomelidae, Lagriidae, and Alleculidae) studied. One of the main criticisms of the paper is that he has slavishly followed Verhoeff in his interpretation of all the structures. He expresses the opinion that "Die Styli sind stets entweder gegliederte oder ungeliederte Ahänge des 9. Sternits."

The final paper that has come to my attention is one on the "Comparative Morphology of the Genitalia of Insects" by Anna Grace Newell (1918) published in 1918. This paper fails however, to add anything to the knowledge of the female genital structures of the beetles.

The scantiness of the literature on this subject reveals a great unexplored field in which much is held in store for the future workers. It is almost impossible at the present time to deduce the truth of the phylogeny of the beetles, when approached from this angle, without studying a good representation of all the families.

General Morphology of the Genitalia

This study is mainly concerned with the morphology of the genitalia, which consist of the eighth, ninth, and tenth abdominal segments and their appendages. There are apparently ten segments in the abdomen of most adult female beetles. The eleventh somite has been disregarded as it is only to be found as a membranous remnant around the anal aperture of the tenth tergite. The spiracles are one of the most useful sets of structures in determining the segmentation of an adult beetle. This is because there are never more than eight pairs of abdominal spiracles present in any fully developed insect. The first pair of spiracles are usually large and situated in the conjunctiva near the posterior margin of the thorax. This pair of spiracles belongs to the first abdominal segment and caudad of this segment there are usually seven other somites each bearing a pair of spiracles the number of these segments thus being definitely determined. The Coccinellidae and some Histeridae seem to bear but seven pairs of abdominal spiracles.

Eighth Segment.—The eighth segment is present as a distinct tergite and sternite in all species studied. The eighth spiracle is located in the conjunctiva of this segment, or near the ventral margin of the tergite. The tergite of this segment is in most cases chitinized and setiferous. The sternite is greatly modified in comparison with the tergite. In some cases it is shield-shaped and divided into two parts on the middle by a small strip of membrane (Figs. 24, 25). In *Laccophilus maculosus* (Figs. 30, 31) there has developed from the middle part of the sternite a saw-like structure which has grown posterially and is about the length of the coxite. In other species as (Figs. 76, 77), (Figs. 86, 87, 88, 173, 174, 181, 182, 183, 184, etc.) the sternite is greatly modified and bears one or two apodemes which extend cephalad into the body. In the Cicindelidae (Figs. 1 to 12, 187 to 203) the eighth sternite is shown to bear interesting specific characters which have not been previously utilized. This segment, as well as those posterior to it, is retracted within the body when not in use.

Ninth segment:—The ninth tergite and sternite are, as a rule, membranous; however, the following species seem to present exceptions to this (Figs. 89, 90, 167, 168). In these species there

seems to be a definite chitinization of this segment. Wandollek (1905) considered the structures I have designated paraproct, valvifer, and coxite as tergite or sternite of the ninth segment. In this he followed Verhoeff (1894) who also contends that "Die 9 V. ist immer zweitheilig und tragt auf jeder Halfte einen ungegliederten Stylus." I am inclined to follow Crampton (1925), and Wheeler (1893), who have considered these structures as rudimentary abdominal appendages and designated them ninth valvae. The ninth valvae consist of the valvifers, coxites, and styli. MacGillivray (1923), however, contends that the "octapophyses" have migrated caudad from the eighth segment to their present position, the posterior margin of the ninth segment. From all the evidence obtainable there seems to be no reason for considering these as structures of the eighth segment.

Dr. Wheeler's studies (1893) on the development of *Xiphidium* have shown that the appendages of segments eight, nine, and ten can be traced to the nymphal stage and that some of these appendages take part in the formation of the gonapophyses. In the beetles the appendages of the ninth segment persist while those of the eighth and tenth disappear. These appendages have been interpreted differently by most investigators. Stein (1847) considered them as the divided ninth sternite, Peytoureau (1895) thought they were the eighth sternite in the Dytiscidae and the seventh in the Hydrophilidae, and Verhoeff (1893) considered them the tenth sternite.

My studies of these structures in species of sixty-six families leads me to the conclusion that these genital appendages are the coxites and styli of the ninth segment, and that the valvifers are a chitinized portion of the adjacent end of the ninth sternite which bears the coxites and styli.

The coxites are in (Figs. 1 to 12, 105, 106, 107, 108, etc.) secondarily divided. The division which may be either longitudinal or transverse, seems to be an adaptation in connection with the outward and inward movement of the genitalia. In the reduction of these structures it is the styli and the valvifers that seem to disappear leaving only the coxites (Figs. 157, 158).

The vulva is located in the corea between the coxites, or just caudad of them and between the styli.

There are chitinized remnants of the tenth sternite in some species (Figs. 13, 19, 21, 24, 26, 68, 77, 136, 172, etc.). The tenth tergite which bears the anus has been called the proctiger throughout this paper. It may be that the structure called the paraproct is a part of the ninth tergite which has been shifted around, many times being found near the protiger and in some case, in juxtaposition with the valvifer of the ventral region. This sclerite needs to be homologized with similar structures in other groups in order to come to some satisfactory conclusion as to its identity. Dr. Crampton (1925) has suggested that the paraproct of the beetles may be a part of the ninth tergite called the surstylus in other insects (Trichoptera). In some species studied the paraprocts are absent.

I propose to call the rod-like structures of the paraprocts, valvifers, and coxites, indicated by *b*, in many of the figures, the baculi. This term comes from the Latin and means rod or staff. These do not seem to be apodemes in the true sense, as they are chitinized rods lying in the integument and serving as stiffening structures for the long membranous expanses of the ovipositor.

Morphology of the Species Studied

The following summary of family characteristics is brief since the figures have been carefully homologized and labeled. Species from each family have been figured.

Cicindelidae

Species studied: *Collyris acrolia* Chaudoir, *Therates semperi* Sch., *Therates labiatus* Fav., *Tricondyla cyanipes* var. *planiceps* Schaum., *Cicindela striolata*, *Cicindela oregona* Lec., *Cicindela arizonae* Wickh., *Cicindela imperfecta* Lec., *Cicindela hirticollis* Say, *Tetracha carolina* L., *Omus dejeani* Roche., *Omus laevis* var. *gracilior* Csy. (Figures 1 to 12, 187 to 222.)

Family characters: heavily chitinized two segmented styli, with the exception of the genus *Omus* in which there is but one segment in the stylus; coxites of two or more longitudinal sclerites; well developed valvifers; obvious proctigers and paraprocts; very characteristic eighth sternite, which in some genera (Figs. 1, 2, 11, 12) bear chitinized spines on the meso-posterior margin, some are decidedly emarginate (Figs. 3, 4, 7, 8), while others are pointed (Figs. 5, 6).

This is the only family in which the two segmented stylus was observed. This is clearly a two segmented structure as the figures, taken from a dorsal view, show. The genitalia are noticeably compact and more complex, than in any other family. I have considered the families of the Caraboidea series, as I have them arranged, to be a very primitive group. The Cicindelidae and Carabidae of this series have all the structures found in any of the other families studied; using these families as a starting point I have been able to homologize all the other families with them.

Carabidae

Species Studied: *Pterostichus adoxus* (Say), *Pterostichus* sp.?, *Pterostichus planctus* Lec., *Brachinus* sp.?, *Calosoma tepidum* Lec., *Scarites californica* Lec., *Galerita lecontei* Dej., *Chlaenius sericeus* Forst., *Harpalus pennsylvanicus* Deg., *Brennus interruptus* (Men.). (Figures 13 to 21, 24, 25.)

Family characters: heavily chitinized one segmented styli; coxite of one sclerite; valvifer well developed; a remnant of the tenth segment, as a sternite; in most species the eighth sternite is divided through the middle by a membrane.

The species in this family show a compactness similar to those of the Cicindelidae. The Cicindelids may be separated from the Carabids by the two segmented stylus, longitudinal divided coxite, and the characteristic eighth sternite.

Amphizoidae

Species studied: *Amphizoa insolens* Lec. (Figures 22, 23.)

Family characters: small stylus; long coxite; small valvifer; and with an eighth and tenth sternite similar to the Carabids.

The Amphizoidae and Omophronidae seem to be closely related to the Carabidae.

Omophronidae

Species studied: *Omophron dentatum* Lec. (Figures 26, 27.)

Family characters: a stylus and coxite, but no valvifer. The eighth sternite is divided in the middle as in the Carabidae. The tenth sternite is present.

The Omophronidae and Haliplidae show a close relationship.

Haliplidae

Species studied: *Peltodytes simplex* (Lec.). (Figures 28, 29.)

Family characters; coxite and valvifer present, but no stylus; paraprocts peculiar in their development; no evidence of a tenth sternite; short and compact in arrangement.

Dytiscidae

Species studied: *Dytiscus marginicollis* Lec., *Laccophilus maculatus* (Germ.), *Hydroporus signatus* Shp. (Figures 30, 31.)

Family characters: long sharp-pointed coxite, without a stylus; valvifer large and articulating with the paraproct; paraprocts and proctiger well developed; a saw-like structure projecting from the meso-posterior margin of the eighth sternite. This is one of the most interesting developments of the eighth sternite encountered.

The Dytiscidae seem to be more immediately related to the Carabidae than to the Haliplidae or the Gyrinidae.

Gyrindae

Species studied: *Gyrinus consobrinus* Lec. (Figures 32, 33.)

Family characters: coxite and valvifer present, stylus absent; no chitinized proctiger and paraproct present.

The Haliplidae and Gyrinidae seem to be closely related.

Hydrophilidae

Species studied: *Hydrophilus triangularis* Say. (Figures 34, 35.)

Family characters: in *Hydrophilus* the proctiger, paraproct valvifer, coxite, stylus, and tenth sternite are present.

In this family all the characters as given above are Caraboid, except the stylus which is Polyphagous. Using the genitalia as a guide this family must be placed with the Caraboids, near the family Carabidae.

Brathinidae

Species studied: *Brathinus californicus* Hub. (Figures 44, 45.)

Family characters: stylus small; two segmented coxite, vertically divided; valvifer medium size and articulating with the coxite; proctiger and paraproct present.

Silphidae

Species studied: *Silpha lapponica* Hbst., *Silpha americana* L. (Figures 38, 39, 40, 41.)

Family characters: stylus set well down on the side of the coxite; coxite long and resembling in shape the stylus of some Carabid species; valvifer rather large and articulating with the paraproct; proctiger and paraproct both present.

The Silphidae have several characters which suggest that they should be considered as primitive forms related to the Caraboid series.

Staphylinidae

Species studied: *Creophilus villosus* Grav. (Figures 36, 37.)

Family characters: a very small stylus; coxite short; valvifer large and articulating with the coxite; the paraproct is long and separated from the valvifer by a small strip of membrane; proctiger large.

The Staphilinidae seem to be more closely related to the Silphidae than any other family studied.

Scaphidiidae

Species studied: *Scaphidium 4-guttatum* Say. (Figures 42, 43.)

Family characters: a small stylus borne on a long slender coxite; no valvifer present; proctiger long and narrow; paraproct large.

The relationship of this family with other Silphoid families is not clearly understood.

Histeridae

Species studied: *Hister semiruber* Csy., *Hololepta populnea* Lec., (Figures 45, 47.)

Family characters: stylus small; coxite large and articulating very closely with the valvifer; valvifer spatulate at the anterior end and rather forked at the end which articulates with the coxite; proctiger and paraproct present. The valvifer is almost completely enclosed within the membranous part of the ninth segment.

Judging from the female genitalia alone, and that is the only guide I have used in making my groupings, the Histeridae seem to belong with the Silphoids, but as an isolated group.

Lycidae

Species studied: *Eros simplicipes* (Mann.), *Calopteron reticulatum* Fab. (Figures 52, 53.)

Family characters: stylus and coxite present; only one valvifer present which is found in the mid-ventral region, the posterior part overlapping the coxites, while the anterior ends extend cephalad to the eighth sternite as baculi.

Lampyridae

Species studied: *Lucidota californica* Mots. (Figures 50, 51.)

Family characters: stylus, coxite, and valvifer present; the coxite and valvifer are long narrow strips. Each valvifer has an arm extending into the mid-ventral region, suggesting that the valvifers may have once been one piece as in *Calopteron*.

The Lampyridae and Lycidae seem to be related.

Cantharidae

Species studied: *Podabrus* sp.? (Figures 48, 49.)

Family characters: stylus small; two segmented coxite; a valvifer which articulates with the paraproct and coxite; the paraproct is large in comparison with the proctiger, valvifer, etc.

The Lampyridae and Cantharidae are similar in most respects except that *Podabrus* has a two segmented coxite.

Melyridae

Species studied: *Collops marginellus* Lec. (Figures 54, 55.)

Family characters: the stylus is small and borne on the end of a coxite which shows signs of secondary division; the valvifer is reduced to a long baculum which articulates with a short baculum of the coxite; the paraproct is also reduced to a baculum.

This family may be used to represent a group of families I am calling the Melyridae Group. All have the long type of ovipositer and have similar characters which seems to show relationship.

Cleridae

Species studied: *Monophylla californica* Fall, *Cymatodera brunnea* Melsh. (Figures 56, 57.)

Family characters: stylus very small; coxite almost divided transversely into two segments; valvifer and paraproct baculi long. The baculi of this Group serve as supports for the long membranous areas of the genital tube.

Corynetidae

Species studied: *Necrobia rufipes* (Deg.) (Figures 58, 59.)

Family characters: this family is similar to the two preceding families.

Lymexylidae

Species studied: *Hylecoetus lugubris* Say. (Figures 60, 61.)

Family characters: stylus near the end of the coxite; the coxite seems to be divided into two segments, when looking at it from a ventral aspect, but if it is studied from the dorsal and lateral sides the division is clearly shown to be only a partial one; the valvifer is large and bears a baculum on its inner margin; a small remnant of the proctiger is present.

Cupesidae

Species studied: *Cupes concolor* Westw. (Figures 62, 63.)

Family characters: the coxite and valvifer are very much reduced, while the paraproct and protiger are completely lost.

Using the female genitalia as a criterion this family cannot possibly be placed with the Adephagous families as recently proposed by Mr. Muir (1924).

Oedemeridae

Species studied: *Copidita 4-maculatus* Mots., *Ditylus quadricollis* Lec., *Calopus angustus* Lec. (Figures 80, 81.)

Family characters: stylus small and borne on the side of the heavily chitinized coxite; the coxite has two small vertical membranous strips which show a lack of chitinization and suggest an adaptation for folding when withdrawn into the body; this also suggests the way of secondary division of the coxite; the paraproct consists of a chitinized tip borne on a long baculum; the valvifer is long.

I am placing this family with the Tenebrionoids.

Mordellidae

Species studied: *Mordella grandis* Lilj. (Figures 64, 65.)

Family characters: stylus small; coxite with a baculum at its base which articulates with the baculum of the valvifer; paraproct baculum long.

The Mordellids seem to be related to the Lycidae and Anobiidae.

Meloidae

Species studied: *Lytta cooperi* Lec. (Figures 66, 67.)

Family characters: the stylus is rather large and borne on the end of a round short coxite; no valvifer present; proctiger and paraproct present.

This family is a very compact type, but must be placed with the Cantharoids.

Pythidae

Species studied: *Pytho strictus* Lec. (Figures 68, 69.)

Family characters: the coxite seems to be divided into two segments when viewed from the ventral aspect, but a lateral view shows that the division is only a partial one; the rest of the characters are similar to other families of the Melyridae group of the Cantharoid series.

Pedilidae

Species studied: *Pedilus* sp.? *Pedilus flavidus* Fall. (Figures 72, 73.)

Family characters: stylus borne on the end of the second segment of the coxite. Valvifer reduced to a baculum.

I have placed this family along with the Melyridae group.

Anthicidae

Species studied: *Anthicius alacer* Csy. (Figures 70, 71.)

Family characters: stylus small; coxites very close together in the mid-ventral region and with a partial division on the ventral side.

This family belongs with the Melyridae group.

Elateridae

Species studied: *Ludius manrus* Lec., *Melanotus communis* (Gyll). (Figures 84, 85.)

Family characters: stylus and coxite small; coxite ventrally divided and pointed at the place of articulation with the valvifer; valvifer a long baculum.

This family I have placed with the Rhipiceridae group of the Cantharoid series.

Cebrionidae

Species studied: *Cebrio mandibularis* Lec. (Figures 78, 79.)

Family characters: stylus only a remnant which is found in a membranous area on the side of the coxite; the coxite is large and rather heavily chitinized; a vestige of the tenth sternite extends from the base of the coxites to the vulva. The valvifer is large and chitinized, with a heavy baculum along the dorsal margin. Proctiger very vestigial.

I have placed this family at the head of a group in the Tenbrionoid series.

Plastoceridae

Species studied: *Euthysanius lautus* Lec., *Euthysanius pretiosus* Lec. (Figures 76, 77.)

Family characters: the stylus is a membranous vestige of the chitinized styli of other families; the coxite is large and chitinized, likewise the valvifer, which also has a large baculum extending the entire length of the lateral part.

This family seems to be closely related to the Cebrionidae so I have placed it in this group of families.

Rhipiceridae

Species studied: *Sandulus niger* Knoch. (Figures 74, 75.)

Family characters: stylus small; coxite partially divided on the ventral surface; tenth sternite present; the valvifer is present only as a long slender baculum.

This family seems to be related to the Cantheroids.

Melasidae

Species studied: *Melasis rufipennis* Horn., *Anelastes druryi* Kby., *Dromaeolus nitens* Horn. (Figures 82, 83.)

Family characters; very similar to those of *Sandalus*, except the tenth sternite which is present in *Dromaeolus*.

I have put this family in the Rhipiceridae group of the Cantharoids.

Buprestidae

Species studied: *Chrysobothris debilis* Lec., *Buprestes aurulenta* L., *Buprestes langi* Mann., *Acmaeodera* sp.? (Figures 91, 92.)

Family characters: stylus very much reduced; the baculi are the only chitinized parts of the coxites and valvifers; the baculum of the valvifer is large and strong; the proctiger is large and has

two baculi which extend around to the ventral surface where they meet and articulate with the basal parts of the valvifers; on the dorsal part of the coxite there is a baculum. The membranous part of the coxites near the styli are shaped like a fan. This extra surface area at the distal end of the ovipositor may require these extra baculi as supports.

After a careful study of this family I have decided to place them with the Cantharoids and in the Rhipiceridae group.

Dryopidae

Species studied: *Helichus productus* Lec. (Figures 86, 87, 88.)

Family characters: stylus very small; the coxite is black and hard; the valvifer is a black strip of uniform width; the eighth sternite is greatly modified.

This genus is compact in its arrangement, but because it conforms to the general plan of the Cantharoids I have placed it in this series.

Dascillidae

Species studied: *Macropogen testacipennis* Mots. (Figures 95, 96.)

Family characters: stylus small; coxite with a large baculum at its base; baculum of the valvifer long. A vestige of the tenth sternite is present in this genus.

This family, with the Helodidae and Eucinetidae, seem to form a group in the Cantharoid series.

Eucinetidae

Species studied: *Eucinetus infumatus* Lec. (Figures 89, 90.)

Family characters: coxite and stylus present; the proctiger is large. There is no valvifer, but the ventral part of the ninth tergite seems to function as a valvifer. The ninth tergite is definitely chitinized and extends to the base of the coxite and articulates with the same. This ninth tergite suggests what seems to be an explanation of the origin of the paraproct. If this tergite becomes divided along the dorsal mid-line and the remaining parts shifted around, this would result in conditions met with in many of the species studied.

Helodidae

Species studied: *Cyphon concinnus* (Lec.) (Figures 93, 94.)

Family characters: stylus small and borne on the end of the coxite, the coxite is partly divided into segments; the valvifer in this species is a long baculum.

This family is closely related to the Dascillidae.

Dermestidae

Species studied: *Dermestes vulpinus* Fab. (Figures 97, 98.)

Family characters: stylus borne on the end of a two segmented coxite; valvifer and paraproct reduced to baculi.

Because of the shape and general appearance along with the two segmented coxite I am placing this family in the Cucujidae group of the Cucujoid series.

Byrrhidae

Species studied: *Amphicyta dentipes* Er. (Figures 99, 100.)

Family characters: coxite large in comparison with the stylus and valvifer. The paraproct and proctiger present. There are no baculi in this species. It is one of the compact type.

This family belongs with the Cucujoid series, but is rather isolated from any of the groups in this series.

Ostomidae

Species studied: *Temnochila chlorodia* (Mann.) (Figures 103, 104.)

Family characters: This family has the type of stylus, coxite, valvifer, and paraproct that the Cantharoids have and as a result I have placed it with the Melyrodiae group.

Nitidulidae

Species studied: *Glischrochilus cylindricus* (Lec.) (Figures 101, 102.)

Family characters: stylus rather large and borne at the end of a long slender coxite; valvifer chitinized and large; proctiger large; the paraproct reduced to a baculum.

The Nitidulidae belong with the Cantharoids.

Monotomidae

Species studied: *Leptipsius striatus* (Lec.) (Figures 105, 106.)

Family characters: stylus borne on the side of the coxite near its tip; coxite two segmented; valvifer chitinized but small; a very small proctiger.

A member of the Cucujoid series.

Cucujidae

Species studied: *Cucujus clavipes* (Fab.) (Figures 111, 112.)

Family characters; coxite two segmented; valvifer reduced to a baculum; paraproct present only as a baculum.

I have chosen the Cucujidae as a representative family around which to group the families of the Cucujoid series.

Erotylidae

Species studied: *Megalodacne fasciata* (Fab.). (Figures 107, 108.)

Family characters: stylus large; coxite chitinized and two segmented; valvifer large with a strong baculum near its ventral-margin; paraproct long and rather spatulate at both ends; proctiger small.

This family clearly belongs with the Cucujoid series.

Colydiidae

Species studied: *Coxelus pacificus* Horn. (Figure 109, 110.)

Family characters: stylus and coxite small; valvifer and paraproct reduced to baculi.

The characters of this family place it in the Cantharoid series.

Endomychidae

Species studied: *Lycoperdina ferruginea* Lec., *Aphorista laeta* Lec. *Aphorista morosa* Lec. (Figures 113, 114.)

Family characters: stylus and coxite small; valvifer missing; paraproct large; proctiger long and slender and extending far out beyond the genitalia. The eighth sternite is greatly modified.

Phalacridae

Species studied: *Phalacrus ovalis* Lec. (Figures 115, 116.)

Family characters; stylus composed of one segment but borne on a coxite segment which has a three pointed end; coxite two segmented; valvifer long and heavily chitinized; paraproct represented only by a baculum.

Coccinellidae

Species studied: *Hippodamia complex* Csy., *Epilachna corrupta* Muls., *Coccinella californicus* Mann., *Chilocorus bivulnerus* Mulls., *Brachyacantha socialis* Csy. (Figures 117, 118, 120, 121, 122, 123, 124.)

Family characters: the stylus is very small and present in all the species studied, except *Brachyacantha socialis* Csy. and in this species there is no trace of a stylus. The coxite is rather flat and oval in shape, except in *Chilocoxus bivulnerus* Muls., and in this species it is long and rather heavily chitinized. The valvifer and paraproct are present in some of the species and absent in others. The proctiger is large and present in all the species studied.

This family may be characterized by its compactness, lack of baculi, reduced valvifers, and large rather uniform proctiger. I am placing this family with the Cucujoid series, but in a rather isolated position with regard to the other families.

Alleculidae

Species studied: *Hymenorus prolixus* Csy. (Figures 127, 128.)

Family characters: stylus small and borne on the end of the coxite, which is almost divided into two segments. Valvifer reduced to a baculum; no chitinized proctiger and paraproct present.

I have placed this family in the Tenebrionoid series.

Tenebrionidae

Species studied: *Eleodes nevadensis* Blais., *E. dentipes* Esch., *E. lucae* Lec., *E. sculptilus* Blais., *Coniontes opacus* Horn, *Embaphion elongatum* Horn, *Cerenopus cribratus* Lec., *Coelocnemis sulcata* Csy., *Phloeodes diabolicus* Lec. (Figures 125, 126, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138.)

Family characters: all the species studied, with the exception of *Coniontis opaca* Horn, have small styli; the coxite is black and hard, resembling the Caraboid families in this respect. In some of the species the coxite is two segmented. The valvifer, except in *Phloeodes diabolicus* Lec., is large and heavily chitinized. The paraproct is imperfectly developed in this family.

The genera studies are between the compact type and the long Cantharoid type. They show a close relationship to the Oedomeridae and Lagriidae.

Lagriidae

Species studied: *Arthromacra aenea* (Say). (Figures 139, 140.)

Family characters: stylus small and borne on the end of a two segmented coxite. Valvifer membranous, with the exception of a short baculum. Proctiger and paraproct small.

Monommidae

Species studied: *Hyporhagus gilensis* Horn. (Figures 141, 142.)

Family characters: the stylus, coxite, valvifer, paraproct, and proctiger are characteristically those of the Cantharoid families and I have placed this family in the Melyridae group.

Melandryidae

Species studied: *Melandrya striata* Say (Figures 143, 144.)

Family characters: stylus borne at the end of a two segmented coxite; the valvifer and paraproct reduced to baculi.

I have placed this family with the Cucujoids.

Anobiidae

Species studied: *Trichodesma gibbosa* (Say). (Figures 145, 146.)

Family characters: stylus large and borne on the end of a large heavily chitinized coxite. The coxite is membranous in part and possessses two deep folds which look very much like sutures. The valvifer is large and articulates very closely with the coxite. A small proctiger is present. The eighth sternite is greatly modified.

I have placed this family with the Cantharoids near the Lycidae.

Bostrichidae

Species studied: *Polycaon stouti*, *Scobicia declivis* (Lec.), *Amphicerus bicaudatus* Say. (Figures 147, 148.)

Family characters: the stylus, coxite, paraproct, and proctiger are like those of the Melyridae group and I have placed the family in this group.

Sphindidae

Species studied: *Sphindus americanus* Lec. (Figures 151, 152.)

Family characters: stylus borne on the inner side of the second segment of the coxite; coxite two segmented. Valvifer membranous, except the baculum and the basal part; no chitinized proctiger and paraproct.

This family seems to belong with the Cucujoids.

Cisidae

Species studied: *Cis ursulina* Csy., *Octotemnus denudatus* Csy. (Figures 149, 150.)

Family characters: stylus small and borne on the end of a broad odd shaped two segmented coxite. Valvifer oval in shape and overlapping the basal part of the coxite. Proctiger well developed.

I have placed this family with the Cucujoids.

Scarabaeidae

Species studied: *Canthon militaris* Horn, *Diplotaxis* sp.? *Euphoria rufobrunnea* Say, *Catalpa flavida* Horn, *Cotinis nitida* L., *Pelidnota punctata* L., *Cremastocheilus pilosicollis* Horn. (Figures 155, 156, 157, 158.)

Family characters: this family is very homogeneous. None of the species studied possess a stylus; most of them do not have a valvifer. The coxite is short and flat. The paraproct and proctiger are present but in some species very much reduced.

This family is related to the other families of the Scarabaeoids but is more simplified as a result of reduction.

Trogidae

Species studied: *Trox scabrosus* Beauv. (Figures 159, 160.)

Family characters: *Trox* resembles the genera of Scarabaeidae expect that it possesses styli.

The Scarabaeidae seem to be morespecialized than the Trogidae.

Lucanidae

Species studied: *Pseudolucanus mazama* (Lec.), *Sinodendron rugosum* Mann. (Figures 153, 154, 161, 162.)

Family characters: the stylus is present in *Sinodendron* but not in *Pseudelucanus*. The coxite, valvifer, paraproct, and proctiger are present in species of both genera.

The Lucanidae seem to stand between the Trogidae and Scarabaeidae.

Passalidae

Species studied: *Passalus cornutus* Fab. (Figures 163, 164.)

Family characters: the only structures present in this species are the coxite and valvifer.

This family is very closely related to the other members of the Scarabaeoid series. This series is one of the most homogeneous studied. It is rather compact, the coxite seems to be a most constant structure. There are no baculi in any of the species of this series.

Cerambycidae

Species studied: *Desmocerus auripennis* Chev., *Prionus californicus* Mots., *Anicomis lignea* (Fabr.), *Oxoplus coccineus* Csy., *Rhagium lineatum* Oliv., *Ulochaetes leoninus* Lec., *Spondylis upiformis* Mann. (Figures 165, 166, 167, 168.)

Family characters: stylus present; coxite two segmented; valvifer present in some species only as a baculum. Paraproct and proctiger present in most species. The ninth segment is chitinized to a marked extent.

This family is closely related to other members of the Cerambycoids.

Chrysomelidae

Species studied: *Baliosus ruber* (Web.), *Glyptoscelis squamulata* Cr., *Disonycha 5-vittata* var. *pura*, *Tetraopes* sp.? *Chrysochus Cobaltinus* Lec., *Leptinotarsa decemlineata* (Say). (Figures 169, 170, 171, 172, 173, 174.)

Family characters: stylus not present in some of the species; one segmented coxite, which is very large in some species. The baculi of the valvifers and paraprocts articulate very closely. The modification of the eighth segment in *Glyptoscelis* is very interesting.

This family is as homogeneous as the Scarabaeidae. It does not show a very close relationship to the Cerambycidae.

Mylabridae

Species studied: *Mylabris obtectus* Say. (Figures 175, 176.)

Family characters: stylus extremely small; coxite and valvifer articulate closely; large ventral baculum on the valvifer; paraproct reduced to a baculum.

This family shows a relationship to the other families of the Cerambycoids.

Brentidae

Species studied: *Brentus anchorago* (L.). (Figures 177, 178.)

Family characters: stylus and coxite present; the valvifer, paraproct and proctiger are not present. The eighth segment is greatly modified.

This species and family is closely related to Curculionidae.

Curculiondae

Species studied: *Rhodobaenus 13-punctatus* (Ill.), *Pantomorus fulleri* (Horn), *Sphenophorus gentilis* Lec., *Rhynchites bicolor* Fab., *Dorytomus laticollis* Lec. (Figures 179, 180, 181, 182, 183, 184, 185, 186).

Family characters: the stylus and coxite are the only structures present in the species of this family, with the one exception of *Pantomorus fulleri* in which there is present a small baculum which is a remnant of the valvifer. In all the other species the valvifer, proctiger, and paraproct are missing.

This family and Brentidae are closely related and show a marked affinity to the Cerambycidae. Using the genitalia as a guide is no reason for separating these families from the other beetles as a suborder, but they show fundamental relationships with the Cerambycoids and seem to make a natural group within this series.

A Phylogenetic Study

This phylogenetic speculation is based solely upon the findings in connection with this study of the female genitalia. The aim has been to arrange the families and series in such a way as to show relationship. The more primitive beetles have been placed at the head of the list, while those which show progressive modifications follow. It must not, however, be assumed from this that the Caraboids are the primitive stock from which all the other series evolved. Quite the contrary to this is probably true as the evidence supports the conclusion that there are at least two major groups, and possibly three or more, which have developed simultaneously from an extinct Protocoleopterous ancestor.

The Cicindelidae, of the Caraboid series, have been selected as a guide and starting point since they appear to be very primitive, having all the structures any other family possesses. There

seems to be, however, considerable disagreement as to the most primitive family or families. Verhoeff (1918) contends that the Silphidae are the most primitive beetles. Dr. Crampton (1925) thinks the Lampyridae are very primitive, while Sharp and Muir (1912) considered the Byrrhoidea as the most primitive group of Coleoptera. The Cupesidae are also classed with the most primitive of the beetles. When the genitalia alone are used as a guide in grouping these families none of them are entitled to rank with the primitive Caraboids.

The writer is cognizant of the fact that any one structure or set of structures, as the genitalia, cannot be relied upon exclusively as a guide for the accurate classification of the beetles. But since it is now believed that the evolution of the Coleoptera has been in many directions, thus effecting a great many changes in the appendages and body, and since every character has its value in phylogeny, it has seemed worth while to study the classification of the Coleoptera from this point of view.

The conclusions regarding many of the families are only tentative and very unsatisfactory, largely because it has been impossible to study all the families and because large enough series have not been worked over in the families already studied. I believe, however, that enough data is at hand to justify the generalizations and conclusions made in this paper.

One striking characteristic of the female genitalia is their conservatism and simplicity. There are no radical departures from the general type and it has been possible to homologize the structures throughout all the families.

I have grouped the families studied into three suborders and seven series. The third suborder which I have called the Scarabaeiformes is a tentative division, being separated from the other family groups only because of the genital structures.

Suborder ADEPHAGA.—This suborder differs from the Polyphaga and Scarabaeiformes in being more compact and complex. In most of the families the styli are heavily chitinized and adapted for digging. In many of the representatives from the different families the coxite is divided into two or more longitudinal sclerites. There are no baculi in any of the families of this suborder.

Suborder POLYPHAGA.—The genitalia in this suborder is elongate in form and much more simplified than in the Caraboid species. The styli are not so chitinized and are much more setiferous than in the Adephagous species. The stylus in this suborder seems to function principally as a tactile organ. The families of this suborder possess long coxite and valvifer baculi. I have placed five series in this suborder.

Suborder SCARABAEIFORMES.—The genital structures are rather compact in this suborder, but are also greatly simplified and reduced. In some genera (Figs. 157, 158, 163, 164) the coxite is the only important structure remaining. The stylus is vesitigial when present. There are no baculi present in the families studied. This group is very homogeneous and so different from the other two suborders that it may be well considered a distinct major group or suborder.

(1) CARABOID SERIES

I have placed eight families in this series. It contains the same families, with the addition of the Hyrdrophilidae, as does the suborder Adephaga. This series is distinct enough to rank as a major group or suborder, and using the term contributed by Burmeister and now in common usage, this series may be called the Adephaga.

The characteristics of this series may be briefly summarized as follows: a compact ovipositor, consisting of heavily chitinized styli and coxites; well developed valvifer, proctiger, and paraproct. The ninth segment is membranous and short. The tenth sternite is present in many of the species, especially those belonging to the Carabidae. There are no baculi present. In this series the stylus is rarely setiferous but is a structure for digging. No other families show so many primitive characters as do the families of this series.

The Cicinidelidae, except the genus *Omus* possess a stylus which has been considered as a two segmented structure. This may not be the correct interpretation, since it is the only family in the order in which this arrangement appears. There is a possibility of the dorsal segment being a part of the coxite. This point must be studied in more detail in connection with the ontogeny of the species before any worth while conclusions can be reached. The styli of this family and the Carabidae, as shown in plates 2 and 12, are greatly modified.

The Cicinidelidae and Carabidae are apparently closely related, while the Amphizoidae and Omophronidae are derivates from the Carabidae. In *Peltodytes* the coxite and valvifer and a remnant of the paraproct are present while the styli and proctiger are lacking; in this respect the Haliplidae and Gyrindae show a marked similarity. The Haliplidae also show an affinity to the Omophronidae. The Dytiscidae and Hydrophilidae, due to the presence of the well developed coxite, valvifer, and paraproct suggest a close relationship with the Carabidae.

Dr. F. S. Stickney's (1923) study of the Head-Capsule of Coleoptera, which is one of the few good morphological studies of the beetles, is in agreement with the above conclusions.

By using only the genital characters it is not desirable to split up any of the series into superfamilies. Leng (1920) placed the Hydrophilidae as the first superfamily of the suborder Polyphaga. The study of the genitalia of some more genera in this family may show that it should be removed from this series. Sharp and Muir (1912) placed this family with the Byrrhoidea; Ganglbauer (Gahan 1911) put this family with the Diversicornia; and Kolbe (Gahan 1911) thought they belonged with the Heterorrhabda of the Synactostemata.

(2) SILPHOID SERIES

This series represents the first family complex in the second major group or suborder, Polyphaga. But four families seem to belong in this series. The Silphidae, Staphylinidae, and Histeridae are rather homogeneous. All the principal genital structures of these families, with the exception of the styli, are Caraboid in character. One of the noticeable differences between the Caraboids and the other series is the type of stylus. In the Polyphaga it is always setiferous, large at its distal end and borne on the side or the tip of the coxite. The stylus may be used to separate the two suborders.

The Silphidae resemble the Carabidae in many respects. If the stylus of this family be disregarded it could be placed with the Carabidae. The Staphylinidae and Histeridae should be grouped together as they have many characters in common. It is a question just where the Scaphidiidae should be placed. In some respects they resemble the Cantharoid series and in others

the Silphoid complex. *Scaphidium* has no valvifer but its compact character and large paraproct seem to outweigh this shortage. More species of this family should be studied before it can be decided with any degree of accuracy just where it should be placed.

(3) CANTHAROID SERIES

This series includes twenty-five to thirty families. There are four groups in this complex into which most of the families can be placed. These groups may roughly correspond to superfamilies.

The majority of the families belong to what I have called the elongate type, in contrast to the compact type of the preceding two series. The styli are setiferous and very noticeable in most of the families. Long supporting baculi are present in many of the families.

The following families may be grouped about the Lycidae: Brathinidae; Cantharidae; Mordellidae; Anobiidae; and Lampyridae. All these families are of an intermediate type, not so compact as the Carabidae and not so elongate as the Melyridae group. The Brathinidae and Cantharidae have two segmented coxites, the only families in this series where the coxite has been divided. The Mordellidae and Anobiidae are similar and I have placed them together in this group. The Cantharidae and Lampyridae are closely related.

Stickney's conclusions, while not in perfect accord with these findings, agree in the main. Had Stickney attempted a regrouping of the families on the basis of the Head-Capsule structures he would have been forced to make many changes in the arrangement proposed by Leng in this catalogue. After grouping the families according to the genital structures I am surprised to find that there is such a close agreement of the two studies.

Ganglbauer's Diversicornia contains about the same families as my Cantharoid series.

The largest group in this series in the Melyridae assemblage, which contains twelve families. Cupesidae, represented by *Cupes concolor* Westw., apparently must be included in this group. *Cupes* possesses no characters which suggests that it should be ranked with the more primitive Caraboids. Muir

(1924) contends that this family belongs with the Adephaga. Stickney concluded that it should be placed along with the Cleridae and Corynetidae, and not left as a separate superfamily as Leng would have it. The female genital structures lead me to accept Stickney's conclusion. The family Monommidae, represented by *Hyporhague gilensis* presented a problem that could be solved only by placing it in the Melyridae group. This is a radical departure from the other classifications and no doubt needs more study. None of the other members of this group present any outstanding problems. The Buprestidae while shaped peculiarly, possess such structures that they must be classed with the Rhipiceridae group. The Dryopidae of this same group have some characters which suggest Silphoid affinities.

The Helodidae group, composed of three families (Heloididae, Dascillidae, and Eucinetidae) is rather homogeneous, and related to the rest of the families in this series.

The Meloidae, represented by *Lytta cooperi*, due to the compactness of the genitalia, lack of a valvifer and baculum, stands in a rather isolated position in the series. This family should be studied in more detail.

(4) CUCUJOID SERIES

This series is composed of the Cucujidae and Coccinellidae groups. The Cucujidae group is as a whole very homogeneous. All the species of this group are the elongate type, with two segmented coxites, and with long paraproct and valvifer baculi. The Lymexylidae appears to belong in the Cucujidae group. The genital structures of *Hylecoetus* do not justify its being separated from this group and placed in a superfamily Lymexyloidea as Leng has tentatively done.

It has been very difficult to decide whether to leave the Coccinellidae group in the Cucujoidea series or put them in a new series. Leng's Cucujoidea as it now stands seems to be a very artificial assemblage. The genital structures reveal families belonging to at least three superfamilies. The Ostomidae, Nitidulidae, and Colydiidae appear to belong with the Cantharoids and in the Melyridae group. The Cucujidae, Montomidae, and

Erotylidae may well be left in the Cucujoidea; while the Endomychidae, Phalacridae and Coccinellidae seem to belong to some other superfamily, possibly a new one. By leaving the Coccinellidae group in an isolated position in the Cucujoid series the two groups need not be considered as closely related.

The Byrrhidae show greater affinities to the Coccinellidae than any other group in these series.

(5) TENEBRIONOID SERIES

This family complex is composed of seven families. The Oedomeridae, Plasticeridae and Cebrionidae are more closely related to the Tenebrionidae than to any other family studied. *Copidita* and *Arthromacra*, while differing in general appearance, are fundamentally alike. These families have been placed in the same group, but Leng classes the Oedermeridae with the Mordelloid stock. An examination of the body structures other than the genitalia shows that these families are closely related. *Cebrio* and *Euthysanius* are Tenebrionoid in make-up and are very similar to *Copidita*.

This series as it stands is rather homogeneous.

(6) SCARABAEOID SERIES

This is a very homogeneous series. The compactness of the genital structures suggests the primitive Caraboids, while the highly specialized condition suggests a very recent development. In *Canthon*, *Euphoria*, and others, the stylus and valvifer have disappeared and the proctiger and paraprocts are very vestigial; the only structure remaining is a well developed coxite.

The genital structures of the members of this series are, in many respects, so distinct from the other families that they may justifiably be considered as a suborder. I hesitate to suggest such a change, but representatives of these families are much more removed from the balance of the Coleoptera than are the Brentidae and Cucrulionidae.

Species of *Dendroctonus*, *Hylastes*, *Pityophthorus*, and *Ips*, all Scolytids, were studied but no definite chitinized genital structures were found. Since some of the Scolytids are the only beetles with lamellate antennae, similar to the Scarbacidae stock, it does not require an over-imaginative individual to picture the

Scolytids as recent derivatives from the Scarabaeidae stock. While this is a bold leap in the dark, yet there is a little data that may justify such a conclusion.

The families of this series may be arranged in the following order: Lucanidae, Trogidae, Passalidae, and Scarabaeidae.

(7) CERAMBYCOID SERIES

The families in this series belong to several of Leng's superfamilies. The weevils, Chrysomelids, Mylabrids, and Cerambycids, with the possible exception of *Prionus*, agree in most respects. The representatives of the Brentidae and Curculionidae possess no definite characters which would separate them from other beetles as a suborder. The affinities of *Rhynchites*, *Brentus*, etc., with *Mylabris* and *Baliosus* appears to be rather evident. *Prionus* is more anomalous in the Chrysomelid-Mylabrid group than are the representatives of Brentidae and Curculionidae.

The families of this series, especially the weevils, are more highly specialized than any of the other beetles studied. In several species the only genital structures remaining are the styli and coxites.

It is difficult to determine which one of the last two series is the most specialized and recent in their development. Judging from the genital structures alone the Scarabaeidae and Scolytidae are the most specialized of the families studied.

The evidence from this study of the female genitalia supports the grouping of the families into two or three major groups of suborders, namely: Adephaga, Polyphaga, and possibly Scarabaeiformes. Within these suborders are families, which are arranged into series and groups.

The following table suggests the tentative grouping of the families as discussed above:

A Tentative Grouping of the Families Studied According to Their Relationships as Shown by the Female Genitalia

(I have left off the *ea* ending of the series names because this is the conventional superfamily ending.)

ADEPHAGA

(1) CARABOID SERIES

Carabidae . . . . . { Amphizoidae
Omophronidae

Cicindelidae
Dytiscidae
Hydrophilidae

Haliplidae
Gyrinidae

POLYPHAGA

(2) SILPHOID SERIES

Silphidae . . . . . Staphylinidae . . . . . Histeridae
Scaphidiidae

(3) CANTHAROID SERIES

Lycidae . . . . { Mordellidae
Anobiidae
Lampyridae
Cantharidae . . . . Meloidae . . . . . { Helodidae
Dascillidae
Eucinetidae
Rhipiceridae
Melasidae
Elateridae
Buprestidae
Dryopidae
Brathinidae

{ Melyridae
Cleridae
Corynetidae
Nitidulidae
Cupesidae
Pythidae
Pedilidae
Ostomidae
Bostrichidae
Colydiidae
Anthacidae
Monommidae

(4) CUCUJOID SERIES

Byrrhidae . . . . . { Coccinellidae
Endomychidae
Phalacridae

{ Cucujidae
Dermestidae
Monotomidae
Sphindidae
Ciscidae
Lymexylidae

(5) TENEBRIONOID SERIES

Oedomeridae
Plasticeridae
Cebrionidae

Tenebrionidae
Alleculidae . . . . . Lagriidae
Melandryidae

SCARABAEIFORMES

(6) SCARABAEOID SERIES

Trogidae . . . . . Lucanidae . . . . . Passalidae . . . . . Scarabaeidae

(7) CERAMBYCOID SERIES

Chrysomelidae . . . . . { Brentidae
Cerambycidae . . . . . Mylabridae . . . . . { Curculionidae

Specific Structures or Characters Found in the Genitalia of Species of the Genus Cicindela

In my introduction I suggested that the time was ripe for a new method in the study of the beetles. It is my purpose in this section to briefly elaborate this point of view.

Every student of Biology knows that a majority of the plants and animals have been described and given Latin names. These descriptions and names are, theoretically at least, supposed to "make known" and facilitate man's dealings with these organisms. But it is a very serious question just to what extent these descriptions and names actually do help to make known these life forms about us. In the case of the beetles not more than about one-fourth of the known species in America North of Mexico can definitely be determined by means of the original descriptions. In this event the question may well be asked what is the value of systematic work? Does it mean that it is impossible to so describe a species that future workers can use the description for the determination of a species? I am inclined to answer that it does not, but I do believe it means that more care and thought must be put into the descriptions. In the past a great amount of effort, energy, and expense has been largely wasted because so much attention has been paid to extremely variable characters, such as color, color markings, size, distribution, etc. In some genera (for example *Bembidium* with three hundred and fifty species, the descriptions have been based very largely upon color, structure, and distribution, and no detailed morphological study with drawings has been made of any of the species which would help to separate this great group of so-called species. In this genus *Bembidium* it is almost impossible to determine many of the species even by comparison with the type specimen. This seems to emphasize the fact that if the scientific way is the economical way of doing things then more science should be injected into the systematic study of the beetles.

I believe species are morphologically distinct one from another and that these morphological differences should constitute the basic part of the description. Many so-called species are probably only variations or species in the making and not distinct morphological entities which have withstood the vicissitudes of time. Since it has been the method in the past of studying only

the obvious characters, and in many cases the most variable ones, it has lead to the present wasteful and exasperating conditions in systematic Coleopterology.

Much of this confusion could be avoided I believe if all new species were carefully studied, after being relaxed with a weak solution of potash, and then all the structures of the body noted. If these structures were then compared with related species and found to be fundamentally different, accurate drawings could be made of them, these to accompany the descriptions. In this way a much more accurate and thorough knowledge would be had of a species and a concrete reference and means for determination thereby provided for the future workers. I am convinced that it is far better to describe ten species accurately and completely, so the work will not need to be done over again, than to describe fifty species in a superficial manner.

The tiger-beetles (Cicindelidae) are one of the best known groups of beetles, and yet they illustrate in a surprising way how little we actually know about the morphology of the Coleoptera. I have searched in vain for a comprehensive discussion of the morphology of this family. Even Dr. W. Horn's monographic study of the Cicindelidae, which is looked upon by many as a most complete and exhaustive study, fails to discuss the morphology of this group. The reason for this is not clear to the writer, especially when it is seen that there are so many distinctive and obvious characters on all parts of the body which has never yet been adequately discussed.

The figures of plates 14 and 15 show structures from the genitalia of species in the genus *Cicindela*. All these drawings were made from as nearly the same point of view as possible in order to avoid the introduction of differences due to a change in position of the structures. Several specimens of each species were studied in order to determine the variation of the characters. In *Cicindela oregona* the coxite and stylus of twenty-five specimens were mounted in balsam and found to be very conservative in their variations.

A little study of the structures of the eighth sternite (Figs. 187 to 203) shows that they are not as definite and useful as those of the coxite and stylus (Figs. 204 to 222). When all these structures are considered together, however, a species may be rather definitely determined. The sternite characters of *Cicindela*

montana and *Cicindela laurenti* are so similar that they show a close relationship. *Cicindela obliquata* and *Cicindela kirbyi* show a similar relationship in fact these forms are considered by some workers as varieties of *Cicindela longilbaris* and *Cicindela tranquebarica* respectively. The coxite and stylus is shown to be quite distinctive in all the species figured.

Specific differences are found in the genitalia of other families and may be easily studied in connection with the other characters of the body. If such characters as these, as well as other body structures, are accurately drawn and published with the description of the species there ought to be a decided improvement over the descriptions of some of the workers in this field.

The writer contends that all the structures on the body of the insect should be studied, and as many drawings as possible of these characters, published with the descriptions of the species.

Summary

1. In this treatise one hundred and twenty-five genera from sixty-six families of Coleoptera have been studied. The genitalia of one hundred and eleven species from ninety-three genera have been figured and all the structures homologized.

2. The genitalia consist of the eighth, ninth and tenth abdominal segments and their appendages.

3. The appendages of the eighth and tenth segments have disappeared while the appendages of the ninth have persisted.

4. The appendages of the ninth segment consist of the styli, coxites, and valvifers. These are borne on the distal end of the ninth sternite.

5. The proctiger is a part of the tenth tergite. The paraprocts are probably parts of the ninth tergite.

6. There are two typical forms of genitalia, one I have called the compact type and the other the elongate type. The latter possesses coxite and valvifer baculi. The baculi are chitinized rod-like structures in the integument.

7. The Caraboids are considered the most primitive group of beetles. The Cicindelidae have been used as the starting point and guide in this study.

8. The Scarabaeoids are the most highly specialized and seem to be the most recently evolved of all the beetles included in this study.

9. By using only the female genitalia the families studied may be divided into two or probably three suborders and seven series.

10. The representatives of the Brentidae and Curculionidae seem to form a natural group in the Cerambycoid series.

11. Several of Leng's superfamilies, Cucujoidea, Hydrophiloidea, Mordelloidea, etc., appear to be unnatural groups and in need of more study.

12. The specific characters of the genitalia are very useful guides and should be utilized.

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EXPLANATIONS OF PLATES

ABBREVIATIONS

p. . . . . proctiger	spi 8. . . . . eighth spiracle
pp. . . . . paraproct	8tht . . . . . eighth tergite
sty . . . . stylus	9tht. . . . . ninth tergite
c. . . . . coxite	10tht . . . . . tenth tergite
vf . . . . . valvifer	8ths. . . . . eighth sternite
au. . . . . anus	9ths. . . . . nineth sternite
v. . . . . vulva	10ths. . . . . tenth sternite
b. . . . . baculum	

PLATE II

Figs. 1 and 2.—*Collyris acrolia*, ventral and lateral aspects.
Figs. 3 and 4.—*Cicindela imperfecta*, ventral and lateral aspects.
Figs. 5 and 6.—*Tricondyla cyanipes* var. *planiceps*, ventral and lateral aspects.
Figs. 7 and 8.—*Tetracha carolina*, ventral and lateral aspects.
Figs. 9 and 10.—*Omus dejeani*, ventral and lateral aspects.
Figs. 11 and 12.—*Therates labiatus*, ventral and lateral aspects.

Plate III

Figs. 13 and 14.—*Brennus interruptus*, ventral and lateral aspects.
Figs. 15 and 16.—*Scarites californicus*, ventral and lateral aspects.
Figs. 17 and 18.—*Chlaenius sericeus*, ventral and lateral aspects.
Figs. 19 and 20.—*Calosoma tepidum*, ventral and lateral aspects.
Fig. 21.—*Galerita lecontei*, ventral aspect.
Figs. 22 and 23.—*Amphizoa insolens*, ventral and lateral aspects.
Figs. 24 and 25.—*Harpalus pennsylvanicus*, ventral and lateral aspects.

Plate IV

Figs. 26 and 27.—*Omophron dentatum*, ventral and lateral aspects.
Figs. 28 and 29.—*Peltodytes simples*, ventral and lateral aspects.
Figs. 30 and 31.—*Laccophilus maculosus*, ventral and lateral aspects.
Figs. 32 and 33.—*Gyrinus consobinus*, ventral and lateral aspects.
Figs. 34 and 35.—*Hydrous triangularis*, ventral and lateral aspects.
Figs. 36 and 37.—*Creophilus villosus*, ventral and lateral aspects.
Figs. 38 and 39.—*Silpha americana*, ventral and lateral aspects.
Figs. 40 and 41.—*Silpha lapponica*, ventral and lateral aspects.

Plate V

Figs. 42 and 43.—*Scaphidium 4-guttatum*, ventral and lateral aspects.
Figs. 44 and 45.—*Brathinus californicus*, ventral and lateral aspects.
Figs. 46 and 47.—*Canthon militaris*, ventral and lateral aspects.
Figs. 48 and 49.—*Podabrus* sp. ?, ventral and lateral aspects.
Figs. 50 and 51.—*Lucidota californica*, ventral and lateral aspects.
Figs. 52 and 53.—*Calopteron reticulatum*, ventral and lateral aspects.

Plate VI

Figs. 54 and 55.—*Collops marginellus*, ventral and lateral aspects.
Figs. 56 and 57.—*Cymatodera brunnea*, ventral and lateral aspects.
Figs. 58 and 59.—*Necrobia rufipes*, ventral and lateral aspects.
Figs. 60 and 61.—*Hylecoetus lugubris*, ventral and lateral aspects.
Figs. 62 and 63.—*Cupes concolor*, ventral and lateral aspects.
Figs. 64 and 65.—*Mordella grandis*, ventral and lateral aspects.

Plate VII

Figs. 66 and 67.—*Lytta cooperi*, ventral and lateral aspects.
Figs. 68 and 69.—*Pytho strictus*, ventral and lateral aspects.
Figs. 70 and 71.—*Anthicus alacer*, ventral and lateral aspects.
Figs. 72 and 73.—*Pedilus flavidus*, ventral and lateral aspects.
Figs. 74 and 75.—*Sandalus niger*, ventral and lateral aspects.
Figs. 76 and 77.—*Euthysanius pretiosus*, ventral and lateral aspects.
Figs. 78 and 79.—*Cebrio mandibularis*, ventral and lateral aspects.
Figs. 80 and 81.—*Copidita 4-maculata*, ventral and lateral aspects.

Plate VIII

Figs. 82 and 83.—*Dromaeolus nitens*, ventral and lateral aspects.
Figs. 84 and 85.—*Melanotus communis*, ventral and lateral aspects.
Figs. 86, 87 and 88.—*Helichus productus*, ventral and lateral aspects.
Figs. 89 and 90.—*Eucinetus infumatus*, ventral and lateral aspects.
Figs. 91 and 92.—*Chrysobothris debilis*, ventral and lateral aspects.
Figs. 93 and 94.—*Cyphon concinnus*, ventral and lateral aspects.
Figs. 95 and 96.—*Macropogen testaceipennis*, ventral and lateral aspects.

Plate IX

Figs. 97 and 98.—*Dermestes vulpinus*, ventral and lateral aspects.
Figs. 99 and 100.—*Amphicyrta dentipes*, ventral and lateral aspects.
Figs. 101 and 102.—*Glischrochilus cylindricus*, ventral and lateral aspects.
Figs. 103 and 104.—*Temnochila chlorodia*, ventral and lateral aspects.
Figs. 105 and 106.—*Leptipsius striatus*, ventral and lateral aspects.
Figs. 107 and 108.—*Megalodacne fasciata*, ventral and lateral aspects.
Figs. 109 and 110.—*Coxelus pacificus*, ventral and lateral aspects.
Figs. 111 and 112.—*Cucujus clavipes*, ventral and lateral aspects.
Figs. 113 and 114.—*Aphorista laeta*, ventral and lateral aspects.
Figs. 115 and 116.—*Phalacrus ovalis*, ventral and lateral aspects.

Plate X

Figs. 117 and 118.—*Hippodamia complex*, ventral and lateral aspects.
Figs. 119 and 120.—*Brachyacantha socialis*, ventral and lateral aspects.
Figs. 121 and 122.—*Chilocorus buvulnerus*, ventral and lateral aspects.
Figs. 123 and 124.—*Epilachna corrupta*, ventral and lateral aspects.
Figs. 125 and 126.—*Eleodes lucae*, ventral and lateral aspects.
Figs. 127 and 128.—*Hymenorus prolixus*, ventral and lateral aspects.
Figs. 129 and 130.—*Eleodes dentipes*, ventral and lateral aspects.
Figs. 131 and 132.—*Eleodes nevadensis*, ventral and lateral aspects.
Figs. 133 and 134.—*Phloeodes diabolicus*, ventral and lateral aspects.
Figs. 135 and 136.—*Coniontis opaca*, ventral and lateral aspects.

Plate XI

Figs. 137 and 138.—*Coelocnemis sulcata*, ventral and lateral aspects.
Figs. 139 and 140.—*Arthromacra aenea*, ventral and lateral aspects.
Figs. 141 and 142.—*Hyporhagus gilensis*, ventral and lateral aspects.
Figs. 143 and 144.—*Melandrya striata*, ventral and lateral aspects.
Figs. 145 and 146.—*Trichodesma gibbosa*, ventral and lateral aspects.
Figs. 147 and 148.—*Polycaon stouti*, ventral and lateral aspects.
Figs. 149 and 150.—*Cis ursulina*, ventral and lateral aspects.
Figs. 151 and 152.—*Sphindus americanus*, ventral and lateral aspects.
Figs. 153 and 154.—*Sinodendron rugosum*, ventral and lateral aspects.

Plate XII

Figs. 155 and 156.—*Pelidnota punctata*, ventral and lateral aspects.
Figs. 157 and 158.—*Euphoria rufobrunnea*, ventral and lateral aspects.
Figs. 159 and 160.—*Trox scabrosus*, ventral and lateral aspects.
Figs. 161 and 162.—*Pseudolucanus mazama*, ventral and lateral aspects.
Figs. 163 and 164.—*Passalus cornutus*, ventral and lateral aspects.
Figs. 165 and 166.—*Rhagium lineatus*, ventral and lateral aspects.

Plate XIII

Figs. 167 and 168.—*Prionus californicus*, ventral and lateral aspects.
Figs. 169 and 170.—*Glyptoscelis squamulata*, ventral and lateral aspects.
Figs. 171 and 172.—*Chrysoclus cobaltinus*, ventral and lateral aspects.
Figs. 173 and 174.—*Baliosus rubèr*, ventral and lateral aspects.
Figs. 175 and 176.—*Mylabris obtectus*, ventral and lateral aspects.
Figs. 177 and 178.—*Brentus anchorage*, ventral and lateral aspects.
Figs. 179 and 180.—*Pantomorus fulleri*, ventral and lateral aspects.
Figs. 181 and 182.—*Rhynchites bicolor*, ventral and lateral aspects.
Figs. 183 and 184.—*Dorytomus laticollis*, ventral and lateral aspects.
Figs. 185 and 186.—*Rhodobaenus tredecimpunctatus*, ventral and lateral aspects.

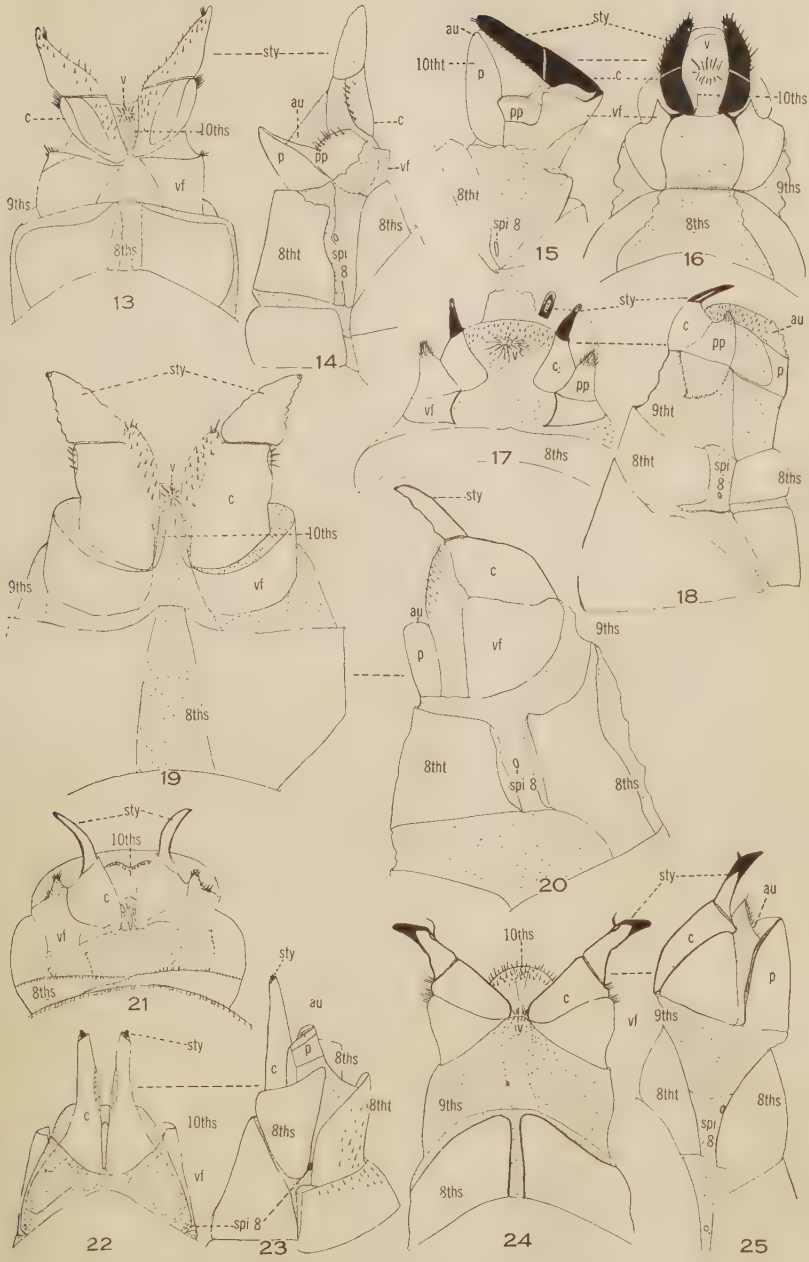
Plate XIV

Figs. 187 to 203 show the specific differences as shown in the eighth sternite (hypopygium) of a number of species of *Cicindela*.

Plate XV

Figs. 204 to 222 show the specific differences as shown in the styli and coxites of a number of species of *Cicindela*.

TANNER—GENITALIA OF FEMALE COLEOPTERA



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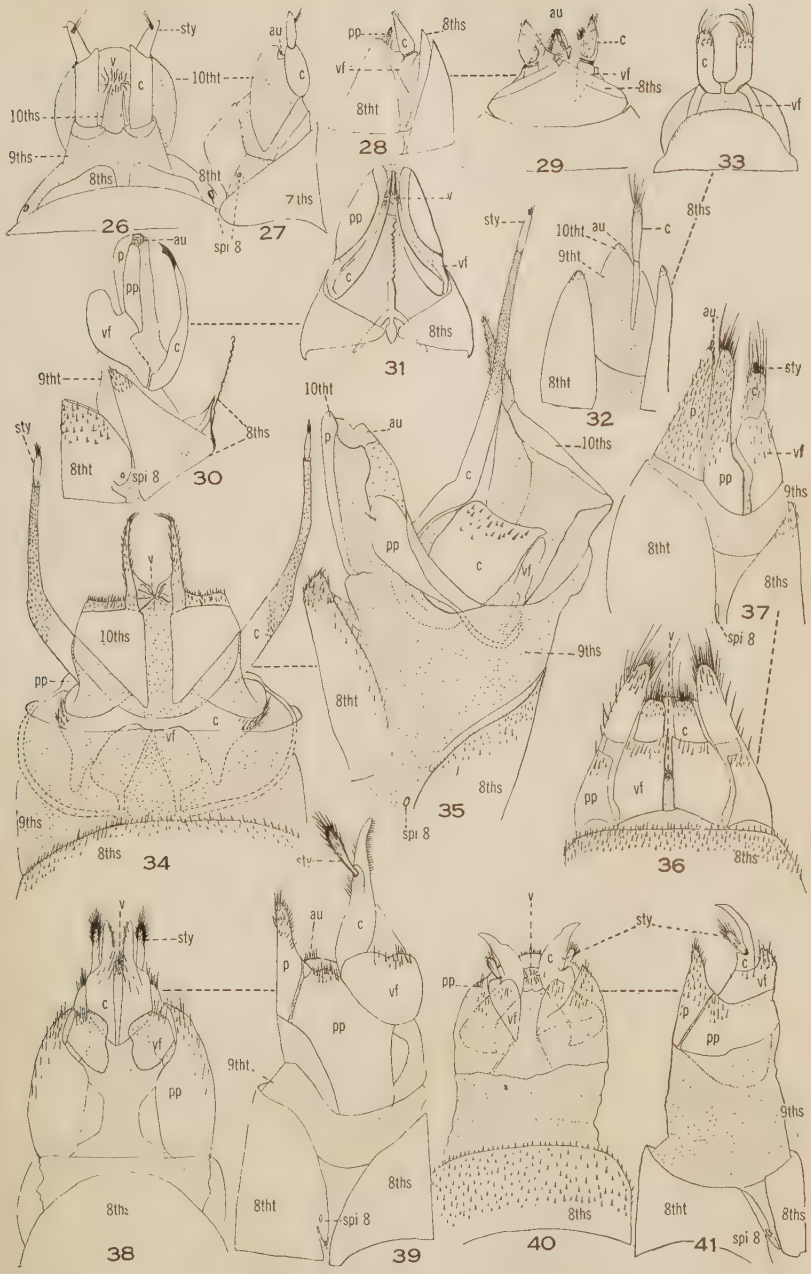

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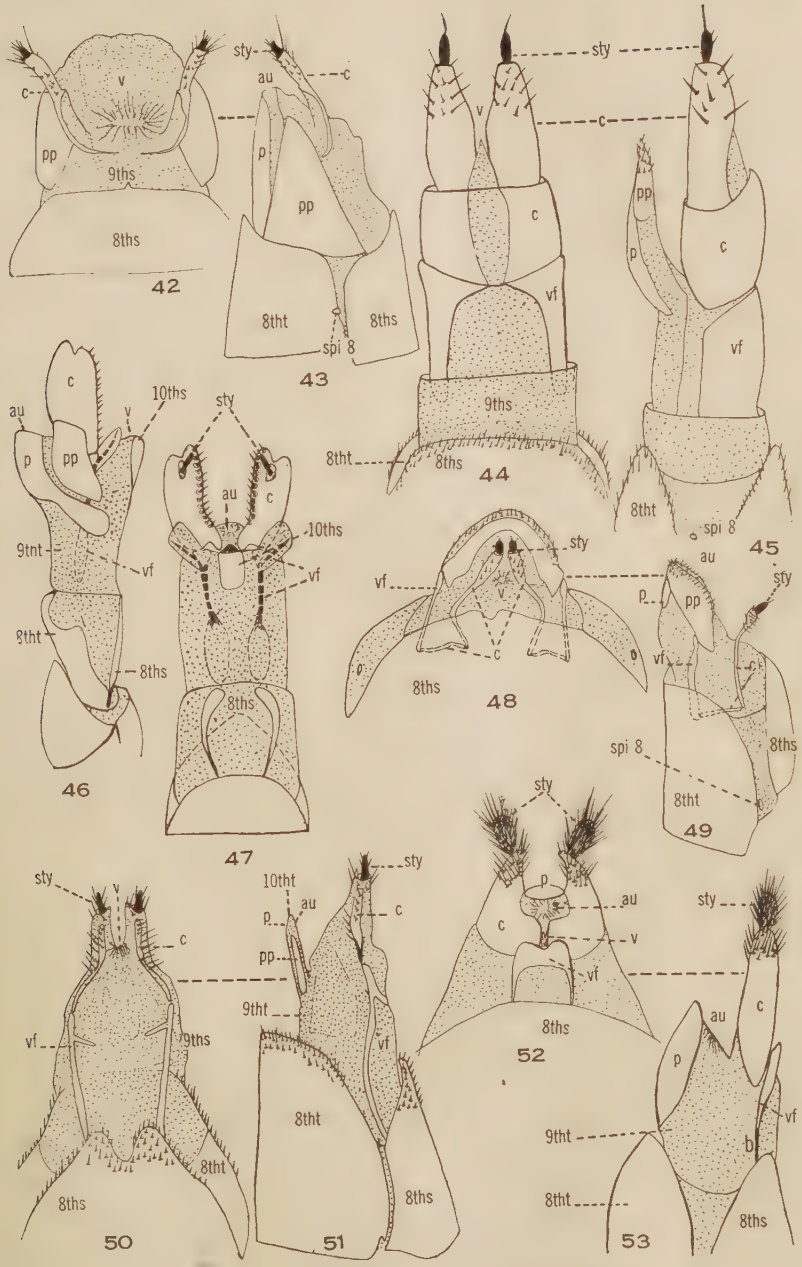

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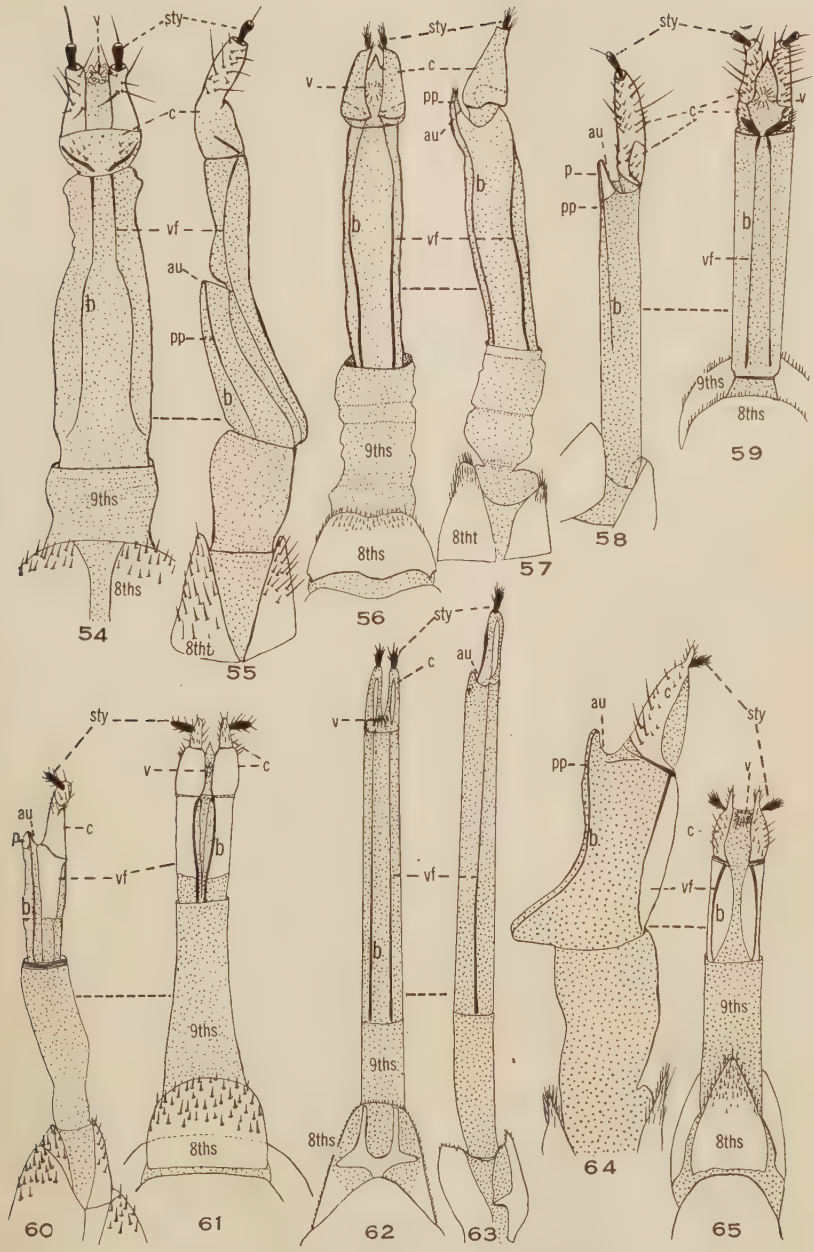

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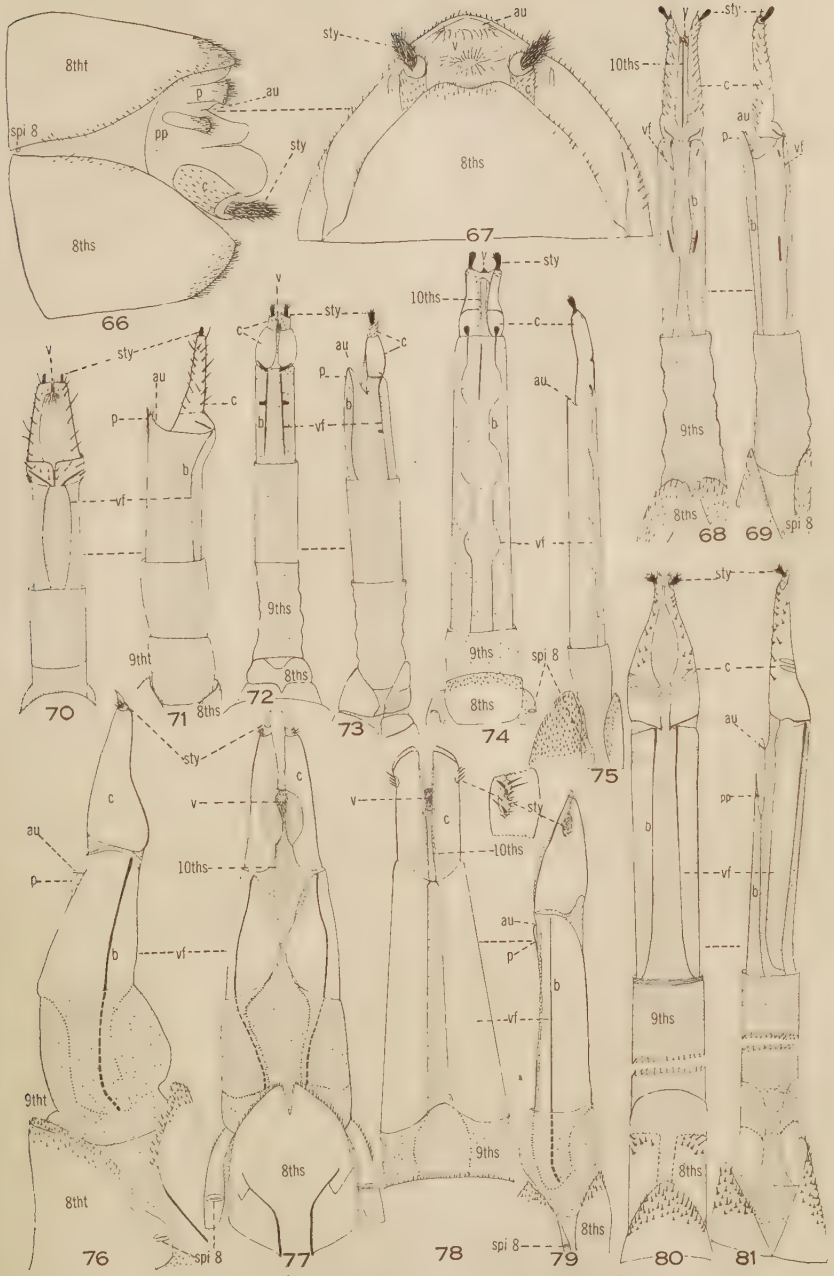

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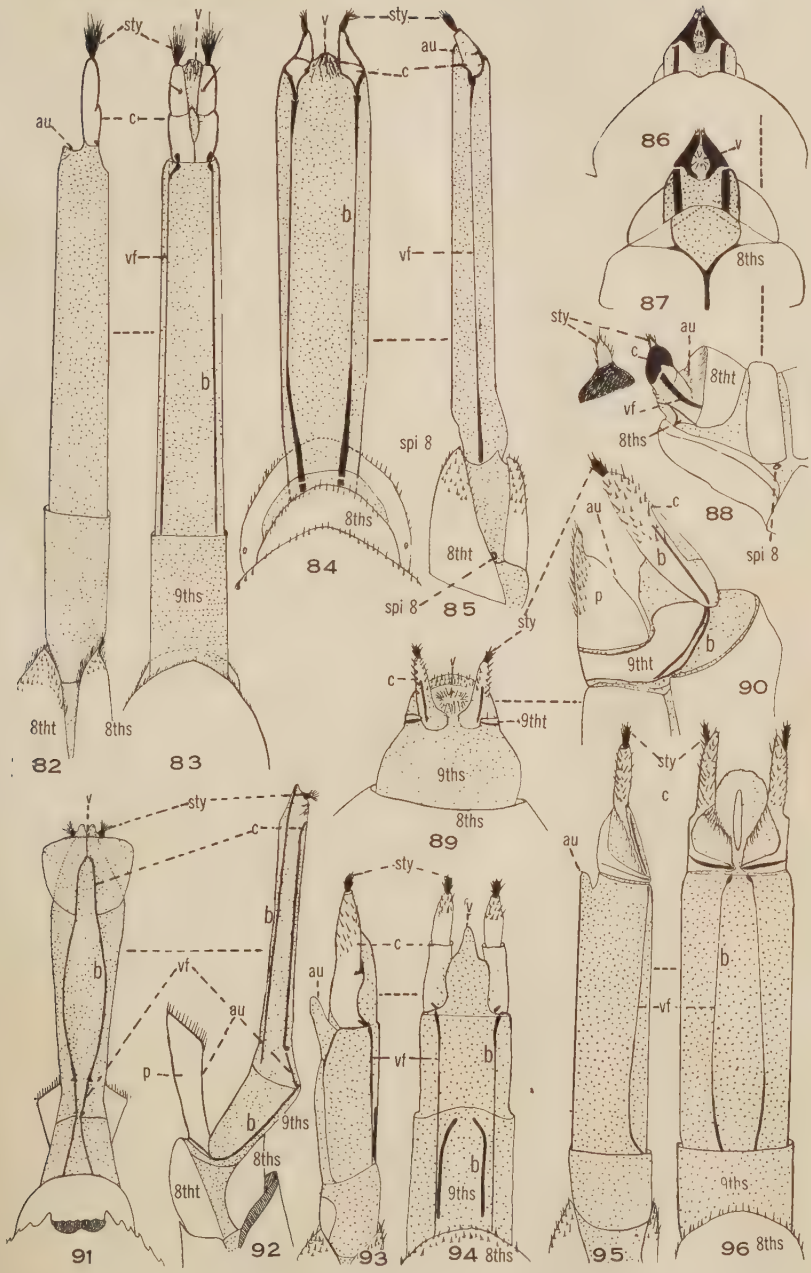

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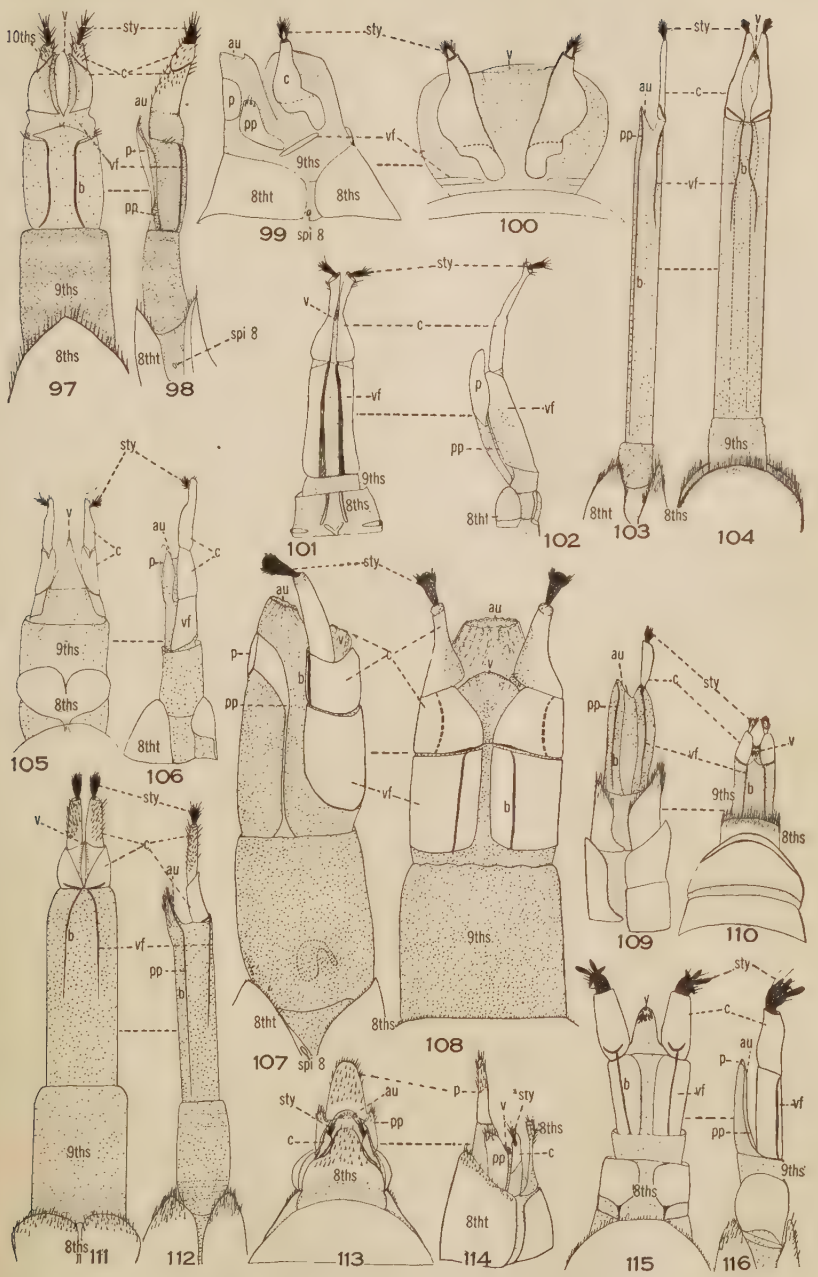

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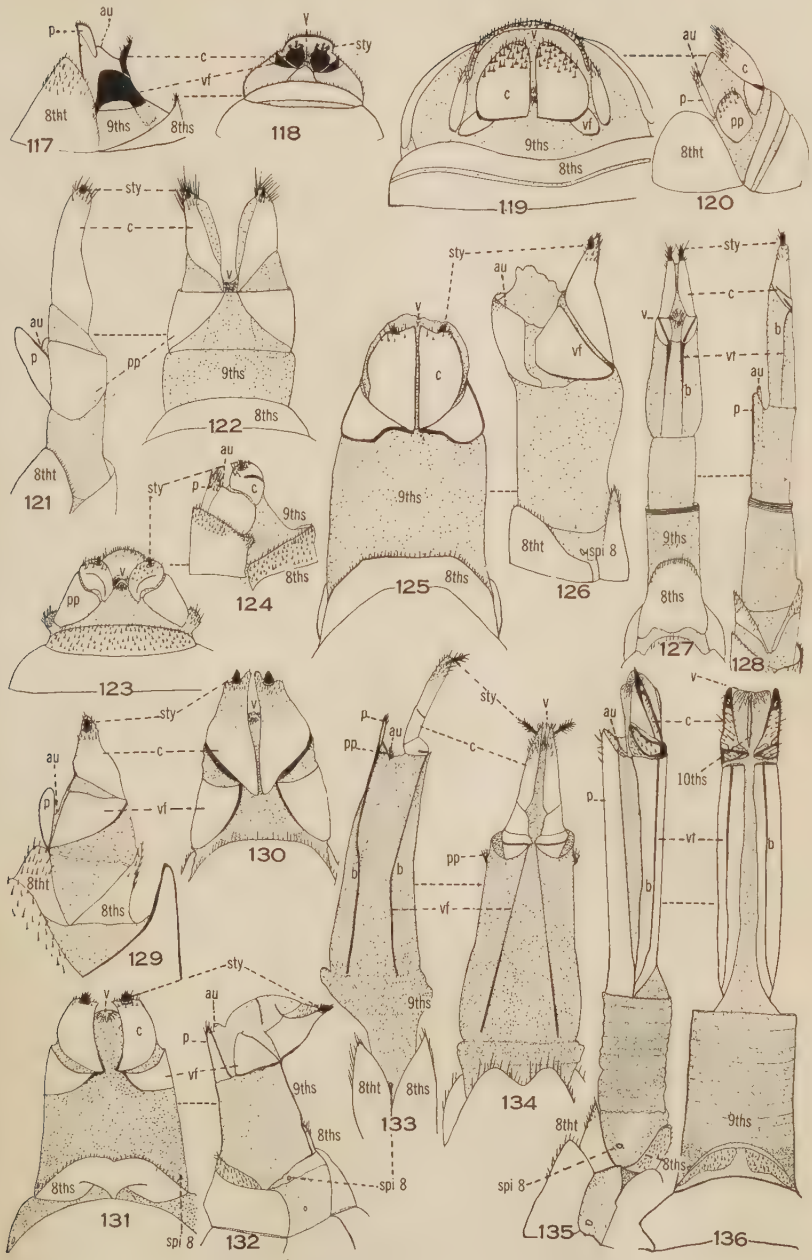

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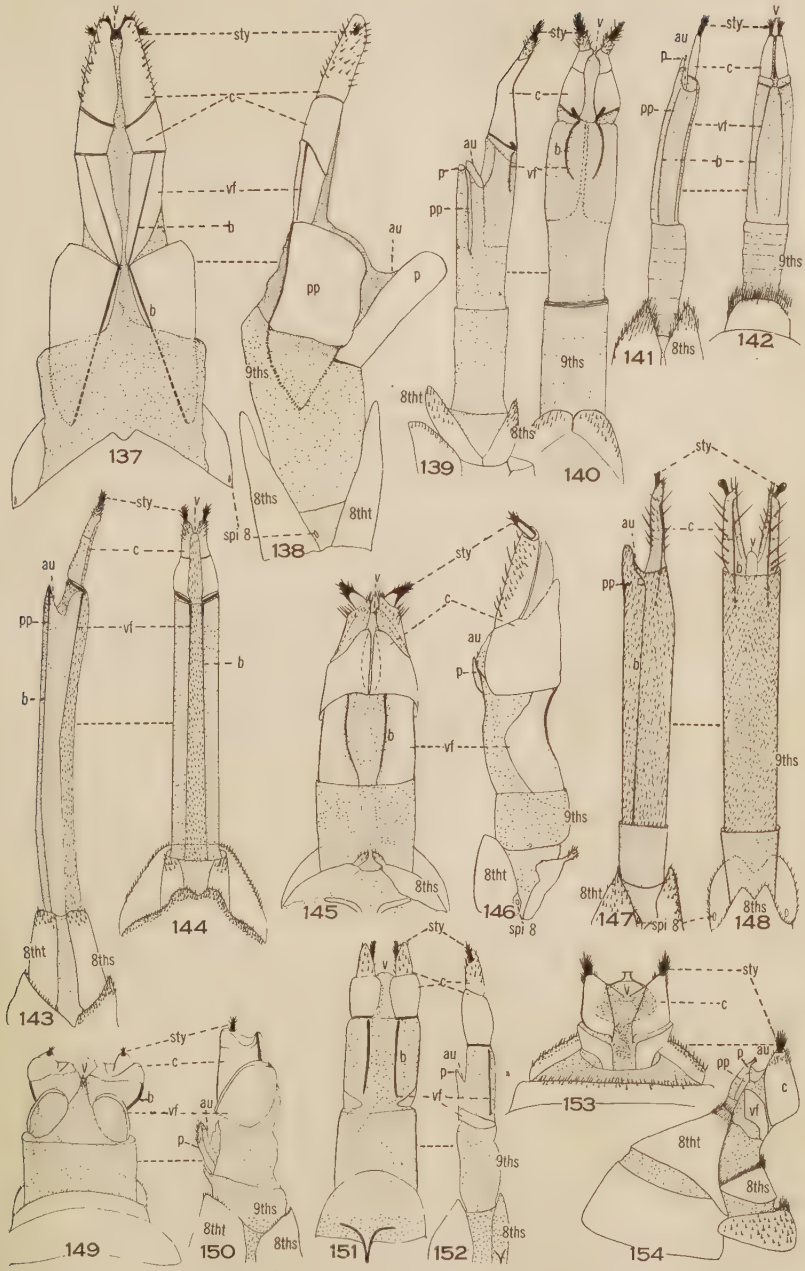

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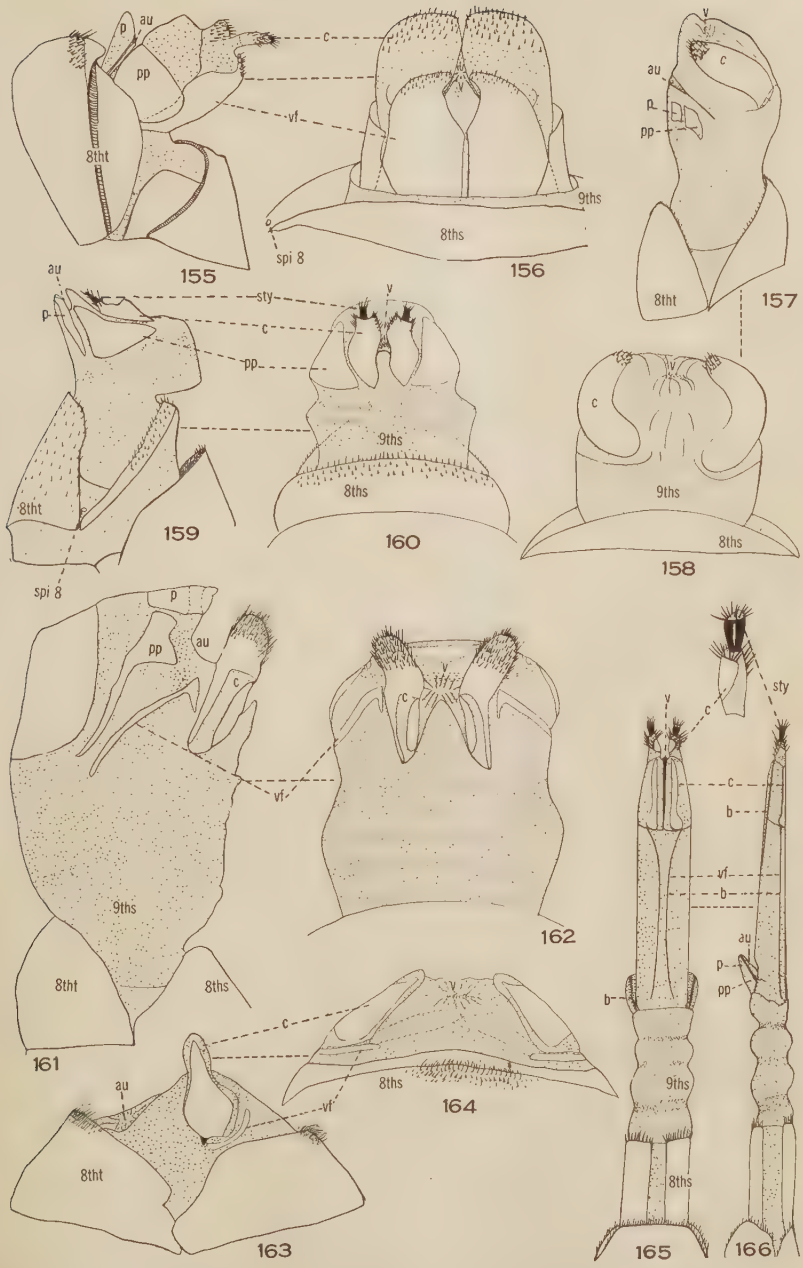

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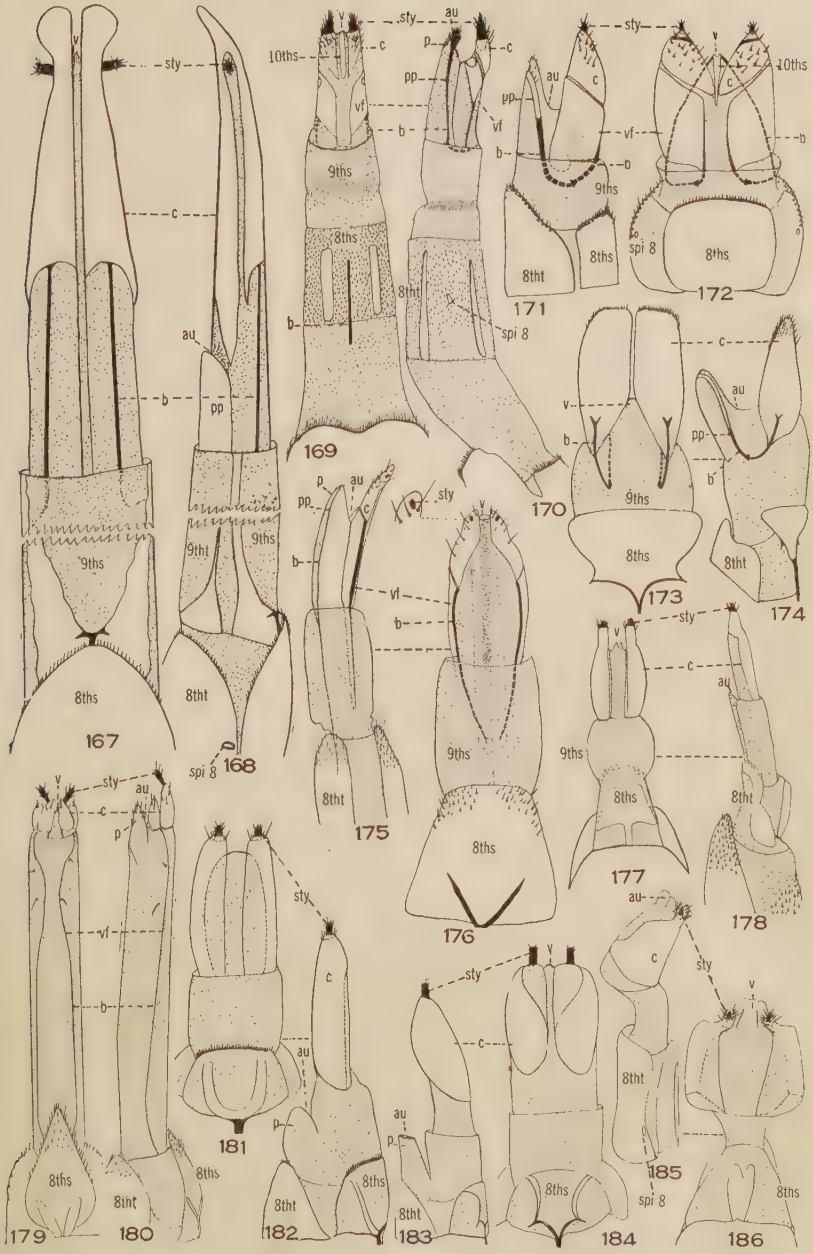

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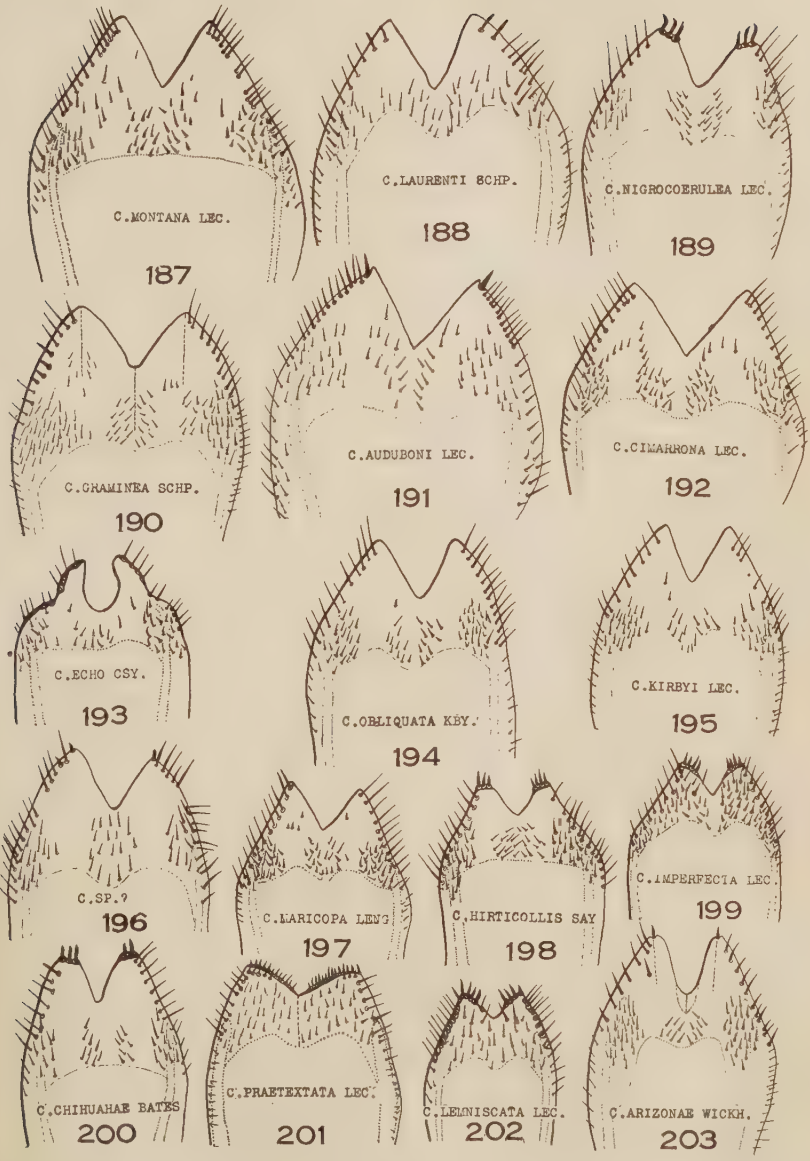

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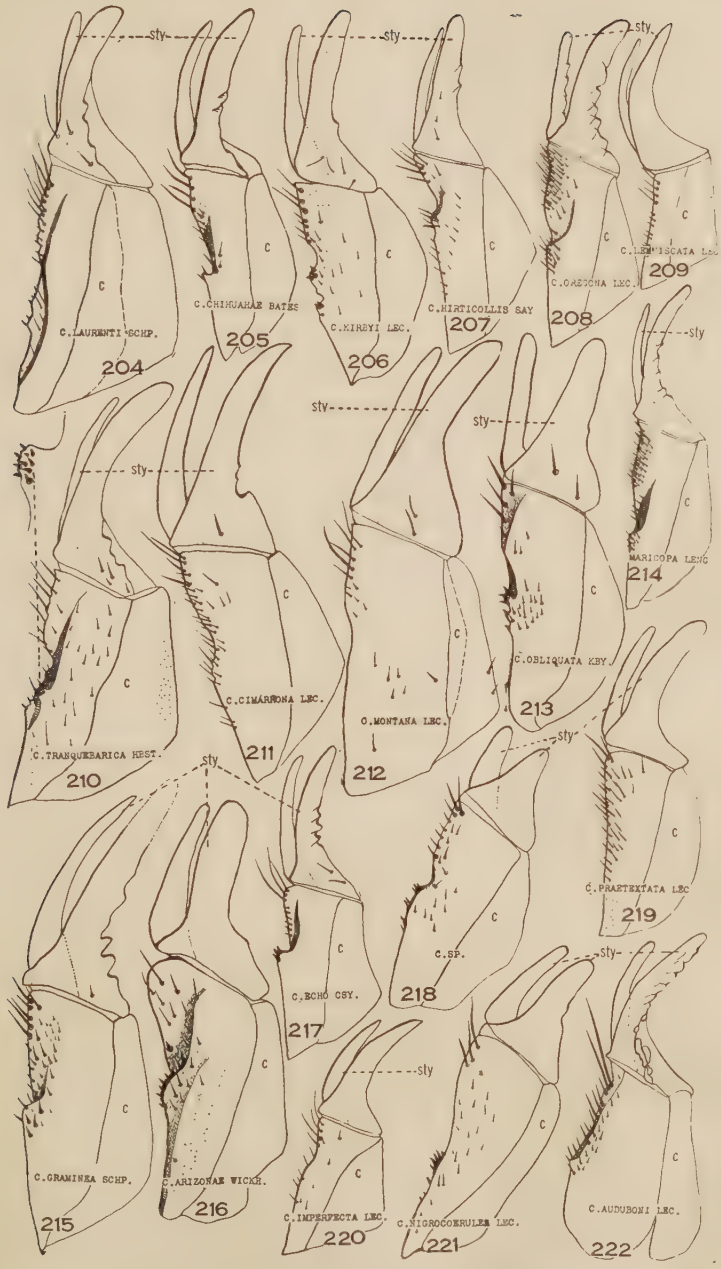

TANNER—GENITALIA OF FEMALE COLEOPTERA

A CONTRIBUTION TO OUR KNOWLEDGE OF THE RELATIONSHIPS OF THE BREMIDAE OF AMERICA NORTH OF MEXICO[1]

(HYMENOPTERA)

BY THEODORE H. FRISON,

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I. Introduction

In the summer and fall of 1910 I opened my first nests of bumblebees with the intention of finding out the manner of their construction and contents. Recourse to the literature of the subject at that time showed that our knowledge concerning the habits of our American species was meager and that most of the information to be found in our text and reference books was based upon studies of European species. Because of the fact that my early investigations yielded so much of interest, and the information concerning our own species was so deficient, a more comprehensive study of the biology of these bees was undertaken.

Too often, one engrossed in the study of the habits or control of insects neglects to determine correctly the object of his observations. In such a case, the otherwise useful observations become a source of confusion and greatly detract from the value of the work. In order that the data obtained by my biological studies might be properly recorded and interpreted from various viewpoints, the writer early set about the systematic study of these bees, and as a result has accumulated a collection almost complete for the North American species, varieties, and castes. As a basis for these studies the publication of Franklin (1913) was found most useful, and careful studies have demonstrated the general soundness of this extensive and monumental work. The accumulation of much additional material since the publication of this excellent paper, as to be expected in long neglected groups, has resulted in some minor corrections and additions. These miscellaneous contributions have been published elsewhere from time to time (Frison, 1916–1926) and need not be reviewed here.

[1] Contribution from the Entomological Laboratories of the University of Illinois, No. 111. Extract number five from a thesis presented to the Faculty of the Graduate School of the University of Illinois in May, 1923, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

The present paper aims to give, in the main, the writer's opinions regarding the relationships of the various natural groups of bumblebees found in America north of Mexico. It is essentially as prepared for an introductory chapter to an unpublished thesis of a biological nature, except for the addition of several features and the incorporation of new information. The increasing interest in the biology and classification of these large social bees, and repeated requests concerning these matters, justifies the publication of this paper at this time.

During the progress of my studies the writer has benefited greatly by the kindness of many individuals. To Dr. Justus Watson Folsom I wish to express my sincere appreciation for having aroused my interest in bumblebees at an early date; under his able direction the greater part of my biological investigations were conducted. To Dr. C. L. Metcalf I am under deep obligation for much assistance and encouragement; under his helpful supervision the original report of my studies was written. To Dr. S. A. Forbes, Dr. A. D. MacGillivray, Dr. R. D. Glasgow, Dr. C. P. Alexander, Dr. F. E. Lutz, Mr. S. A. Rohwer, Mr. J. R. Malloch, Mr. E. T. Cresson, Jr., and others I owe many thanks for their aid with material, valuable criticisms, suggestions, and kindly encouragement. Among the many institutions whose bumblebee material has been studied in entirety or in part, I am particularly indebted to The American Entomological Society for access to the E. T. Cresson, Sr., types of Hymenoptera.

II. Systematic Considerations

A. Position of the Bremidae

From the very earliest historical times the bees, wasps, and ants have been recognized as ranking among the "highest" of insects. For many years the earlier entomologists regarded these groups as being the more specialized of insects. The social habits of many bees and wasps, coupled with their specialized morphology, naturally caused them to be so considered. More recently certain orders of insects, namely, Diptera and Siphonaptera, have been ranked above the Hymenoptera because of certain highly specialized morphological characters. From the view point of morphology, which is the basis of our present clas-

sification, such a rating may be the logical result. If social habits were a true criterion of phylogenetic position, the Isoptera would be placed with Hymenoptera and Diptera; whereas structurally they are among the more generalized of insects. There are many other groups in which psychic development has progressed to a high plane without the accompaniment of corresponding morphological specialization. For example, man is not so very remote morphologically from the higher apes, but his psychic evolution is one of the wonders of nature. Little as we know of the psychology of insects, particularly of such orders as Diptera and Siphonaptera, we are reasonably safe in saying that the higher Hymenoptera psychologically surpass all the other orders of insects. This is mentioned merely to give a general idea of the position of the Hymenoptera, the order to which the bumblebees belong.

Among the Hymenoptera it is still a question as to which families are the highest or more specialized. Most authors, however, are agreed that the ants, bees and wasps, particularly the latter two groups, occupy a high, if not the highest plane. If the ants, wasps, and bees are compared on the basis of psychic development there is probably less to be said in favor of the wasps and bees. Wheeler (1910) in his classic book on ants says of the social bees, wasps, termites and the ants: "adaptive plasticity attains its richest and boldest expression in the ants." Schmiedeknecht, in 1907, separated all kinds of bees into two groups (the parasitic bees and non-parasitic bees). Such a division of the bees is not justifiable, however, if classifications are to have any phylogenetic significance. Friese (1910) points out at some length the fallacy and disadvantages of dividing the bees into two artificial classes as done by Schmiedeknecht. Parasitic or inquilinous habits, such as displayed by certain bees, have undoubtedly arisen independently over and over again among the Hymenoptera. Such habits are therefore but indications of phylogeny within families, genera and lower groups, and not for the larger taxonomic aggregates. Accordingly, in this paper I regard the genus *Psithyrus* as an off-shoot of *Bremus* and regard both as belonging to the same family, the Bremidae.

B. DISCUSSION OF SYSTEMS OF CLASSIFICATION OF THE BREMIDAE

A study of a large number of species of bumblebees from all parts of the world convinces me that the male genitalia offers the most satisfactory and tangible single character for separating the bumblebees into natural complexes. This view was first promulgated by Radoszkowski in 1884 for both European and American species of true bumblebees. Franklin (1913) accepted the available groups of Radoszkowski as the basis for his groupings and where he considered it necessary established several new groups. The fallacy and the absurdity of adopting a system based on color characters, such as proposed by Dalla Torre (1880, 1882), is evident when one considers the great variation exhibited by various species of closely related bumblebees. According to Dalla Torre's grouping, *B. subterraneus* (Linn.) would fall in the subgenus *Leucobombus* (Group I) and *B. distinguendus* (Morawitz) in subgenus *Chromobombus* (Group VI). Structural characters are present, though, which clearly show the very close relationship between these two species. In fact Friese and Wagner (1910) consider them to be varieties of the same species. Krüger (1920), however, gives good reasons for considering them as distinct. The impossibility of using to any advantage such groupings as proposed by Dalla Torre is even more strongly brought out when one considers the extreme variation in color characters often exhibited by a single species; for instance, the common North American species of *B. rufocinctus* (Cress.). Schmiedeknecht (1882–86), first pointed out the weakness in the system proposed by Dalla Torre and erected a new classification of these bees which in many respects was a great improvement over that proposed by Dalla Torre.

Robertson (1903), aside from the recognition of the inquilinous genus *Psithyrus* or so-called false bumblebees by Lepeletier in 1832, was the first person to divide the true bumblebees constituting the present genus *Bremus* (then known as *Bombus*) into two separate genera on the basis of structural characters. Briefly stated, in his genus *Bombias* were included those forms which have unusually large eyes in the males and have in the females rather large ocelli located comparatively far forward on the vertex. Under the name *Bombus* were included those forms having the eyes and the position of the ocelli similar to the condition found in *B. terrestris* (Linn.), the type of the genus. In

the early work of Vogt (1909) we find this author speaking of certain species of palaearctic bumblebees as forming natural groups: for example, "Terrestrisgruppe." This is clearly in line with the system proposed by Radoszkowski in 1884. In 1911, Vogt went a step further and adopted subgeneric names for the complexes that he had previously called groups. In Krüger's recent work (1920) dealing with the bumblebees of Middle Europe the subgeneric names proposed by Vogt are adopted; also one subgenus similarly defined by Ball (1914), together with three of his own creation.

More recently, a very important paper by Skorikov (1922) has appeared in which a classification of the bumblebees of the world is outlined. In this paper, the outlined classification rests upon the fundamental principles pointed out by Radoszkowski (1884) and Vogt (1911). It deviates, however, from the classification of Vogt and others by raising to generic status many groups previously considered as subgenera. As a result, nineteen genera of the true bumblebees are recognized in addition to numerous subgenera. Such a wholesale elevation of natural complexes within a homogeneous group like the true bumblebees does not seem warranted by the writer, particularly in view of the generic concepts in other families of Hymenoptera. Furthermore, his catalog of the bumblebees of the world ignores the basic recognition by Krüger, based upon structural characters, of two sections of the true bumblebees. The recognition of these two sections, plus the one proposed elsewhere in this paper, and the proper assignment of subgenera to them, relieves us of the necessity of raising some complexes to generic rank and leaving others as subgenera in order to bring out closeness or remoteness of relationships.

The publications by Krüger (1917, 1920) merit further analysis at this point as certain of my own studies and conclusions, reaches independently and briefly presented here, are in accord with his. Krüger disregarded color characters as being of greatest importance in determining species and relationships, and attacked the problem from a morphological standpoint. In so doing he developed a means by which exact measurements could be taken of the length and breadth of bumblebee heads, and thus obtained what he designated as a head-index. This index is obtained by the following formula: Index $= \frac{\text{breadth}}{\text{length}} \times 100$.

The measurements were so taken and arranged that an index could be obtained from both minimum and maximum specimens, as well as the mean of a series of individuals. In this way comparable numerical values for all species were obtained. The same general method was also employed for measuring and comparing other areas of taxonomic value and every part of the external anatomy was closely scrutinized. By these exact studies Krüger was able to point out many details of sculpturing, and differences in lengths of certain areas, of European species of bumblebees of classificatory value which were previously overlooked or had not been adequately stressed in systematic studies. Krüger arrived at the opinion that the male genitalia offered the most fundamental and important characters for the separation of the Middle European bumblebees into species and phylogenetic complexes. Principally on the basis of the shape of the middle metatarsus (mesobasitarsus), Krüger further divided the bumblebees in two sections, styled *Odontobombus* and *Anodontobombus*.

Of all the preceding classifications of the various unities within the genus *Bremus*, the one originally conceived by Radoszkowski (1884), and modified by Vogt (1911) and Krüger (1917, 1920) is the system accepted by myself. First, the evidence of morphology or structure in this genus shows that species with genitalia of similar design agree most closely in respect to other structural characters; for example, in the size of the eyes, length of malar space, position of ocelli or shape of mandibles. The color of the pubescence, on the other hand, may be somewhat alike in two species which are structurally remote. In many collections the North American species of *B. borealis* (Kirby) and *B. fervidus* (Fabr.) are confused under one name on the basis of a more or less similar color pattern. One glance at the male genitalia is sufficient to show the great difference between these forms, and this difference is also definitely correlated with other structural characters.

Though the male genitalia may vary slightly, and an occasional abnormal specimen be found, the general plan is constant within a group. *B. impatiens* (Cress.) and *B. fervidus* (Fabr.) belong to different groups as evidenced by the nature of their genitalia. Very minute variations in the genitalia may exist among a series of individuals of either *B. fervidus* (Fabr.) or *B. impatiens* (Cress.) but in no case does a variation occur which bridges the gap

between the two. The use of a system which takes into consideration mathematical relationships, such as the length of the head or length of the malar space, does not give us such decidedly marked groups. For instance, if we were to list the bumblebees in order from the species with the shortest malar space to the species with the longest malar space, species would be thrown close together which are clearly widely separated phylogenetically. *B. impatiens* (Cress.) has a comparatively short malar space and would be fairly well removed from a species such as *B. flavifrons* (Cress.). In fact these two species would be placed in association with other species widely different from them in respect to other characters. The length of the malar space apparently varies slightly within the species, which is another objection to the use of such characters or the employment of mathematical methods for determining phylogeny. Of course, each species presents a normal or mean condition which reminds one in some respects of Galton's figures and conclusions regarding the inheritance of stature in man. Several species may have a mean length of the malar space which is nearly the same, and if this occurs within a group well marked off by other less variable characters, it aids in defining that particular group. In other words, my studies show that in bumblebees a conspicuous difference in design of the genitalia may be likened to a difference of kind, whereas a difference in the length of a character such as the malar space may be likened to a difference in degree, and accordingly the latter is to be considered in a natural grouping of species only within groups previously characterized by a difference of kind.

C. SYSTEM OF CLASSIFICATION ADOPTED BY THE AUTHOR

Because of my acceptance and advocacy in this article of two genera, three sections and twelve subgenera for the members of the Bremidae in America north of Mexico my reasons for so-doing need some explanation.

1. Genera

Little need be said in support of the division of the Bremidae into two genera; *Bremus*, the true bumblebees, and *Psithyrus*, the inquilinous bumblebees. At the present time such a divison is accepted by all students of this group of bees, with the exception

of Skorikov who is forced to elevate them to higher rank because of his recognition as genera of groups previously considered as subgenera. In the past, they have been raised to subfamily rank by a few writers and Ashmead (1899) even elevated them to family status. All of which is sufficient to indicate the clearness of the demarcation existing between these two natural groups of bees.

An abbreviated account of the differences existing between the true and inquilinous bumblebees is sufficient to show the necessity for considering them at least as separate genera. In females of the genus *Bremus* the hind tibiae are modified so as to bear what are commonly called "pollen-baskets." In the genus *Psithyrus* the females lack this provision for the carrying of pollen; the hind tibiae being convex and hairy. Furthermore, the hypopygium of a female of *Psithyrus* is provided with a noticeable carina along each lateral margin, a condition not found in the true bumblebees. Biologically, *Psithyrus* is dependent for its existence upon the true bumblebees, whereas the true bumblebees are absolutely independent of the false bumblebees or *Psithyrus*. The males of *Bremus* and *Psithyrus* are superficially much harder to distinguish from each other than are the females. In most species of *Bremus* the outer surfaces of the hind tibiae are somewhat bare, and in *Terrestribombus* the hind tibiae tend to have corbicula somewhat similar to those found on the females. In *Psithyrus*, however, the outer surfaces of the hind tibiae are hairy. A conspicuous amount of yellow pile on the face of a male is a good indication of a member of the genus *Bremus*, since in the males of *Psithyrus* the face is always dominantly black. Good structural differences exist in the males of these two genera to enable their ready and positive separation. The volsella and squama of the genitalia of males of *Psithyrus* are almost membranous, whereas in *Bremus* they are corneus. The shape and construction of the genitalia of both genera, strongly support the contention of their generic relationship as well as the propriety of placing them in the same family.

My objections to the recognition of nineteen genera within the true bumblebees, besides numerous subgenera, as proposed by Skorikov (1922) in his "Catalog" have been given at another place in this paper.

2. *Sectional Names*

Krüger in addition to the adoption of subgenera of *Bremus* (= *Bombus*) proposed two sections, *Odontobombus* and *Anodontobombus*, for the reception of the Middle European species of bumblebees. These sections were established principally on the basis of the shape of the middle metatarsus (mesobasitarsus). Just as Robertson's (1903) genus *Bombias* has Eurasian representatives, Krüger's *Odontobombus* and *Anodontobombus* find their expression in American forms. Krüger cites the biological division of the British bumblebees as given by Sladen (1912) as evidence of the naturalness of his two sections. I have found in *B. auricomus* (Robt.), a species which belongs to Robertson's *Bombias*, behavior traits which might be cited as showing the naturalness of Robertson's classification. In fact, Robertson's and Krüger's major divisions of the true bumblebees both contain elements of structural and biological strength. Morphologically, *Bombias* and *Bombus*, the Robertsonian subgenera, are certainly as well or better maked off in most species than are the sections *Odontobombus* and *Anodontobombus*. Moreover, there are species under either classification that are somewhat transitional in character. It seems to me, therefore, that within *Bremus* we are dealing with at least, three main lines of descent, namely, the sections *Odontobombus*, *Anodontobombus*, and those forms Robertson called *Bombias*. Accordingly I am grouping together as a new section, equivalent in rank with Krüger's sections, those forms considered by Franklin (1913) as belonging to the subgenus *Bombias* of Robertson, and for the sake of uniformity of sectional names give this section the name of *Boopobombus*.

3. *Subgenera*

I have already pointed out the groups erected by Radoszkowski and the influence they have had on our present classification. Attention has been directed, also, to the fact that some Middle European workers have adopted the use of subgeneric names which in the case of Vogt and Krüger are homologous with the groups of Radoszkowski and Franklin. Added cause for confusion lies in the recognition by Robertson of two genera within the genus "*Bombus*" (*Bremus*) and the reduction of the Robertsonian genera *Bombus* and *Bombias* to subgeneric rank by Franklin. Thus one engaged in extensive biological

studies of the bumblebees is confronted with the problem of reducing to similar categories species of like complexes, whether they occur in Europe or America. The use of Robertson's two genera as subgenera is not adequate for this purpose. An additional factor necessitating similar categories for species occurring in different regions of the world lies in the fact that two homologous complexes may bear dissimilar names. For instance, the *Kirbyellus* Group of Franklin is the subgenus *Alpinobombus* of Krüger.

To the writer the recognition of subgenera seems preferable to the use of "groups," and accordingly I have adopted the use of subgeneric names for those North American species of *Bremus* and *Psithyrus* heretofore classed in American literature as groups. This is in line with the scheme followed by Vogt, Ball, Krüger, and partially Skorikov, except that none of these authors divided *Psithyrus* into similar subgenera. Such subgenera do exist and it is not logical where both genera are considered, as in this paper, to separate *Bremus* into subgenera and ignore a similar treatment of the species belonging to the genus *Psithyrus*. Hence, subgeneric names are proposed for comparable subgenera of *Psithyrus*.

The ever-present danger in using groups as the basis of remarks concerning phylogeny and biology is the adoption of heterogeneous groups. There has been no evidence thus far produced to show that parallelism within the bumblebees in the development of the type of genitalia has taken place. If this is true, the only danger in using the genitalia as the key to the correct placing of both *Bremus* and *Psithyrus* in homogeneous natural subgenera lies in the formation of groups too inclusive. A study of the genitalia of all the North American species of *Bremus* and *Psithyrus* leads me to the conclusion that all the groups adopted by Franklin, with the exception of his *Fraternus* Group, are homogeneous.

In view of the statements just made, one must not get the impression that within the subgenera no further indications of natural complexes are found. The subgenus *Pratobombus* Vogt contains over twenty North American species and provides ample evidence that this subgenus is in the course of active progressive evolution. Various characters are available to separate the included species, but it is clearly evident that such species as *flavifrons* (Cress.), *centralis* (Cress.), and *vagans* (F.Sm.) form a

segregate contrasting with another segregate containing such species as *huntii* (Greene), *ternarius* (Say), and *sylvicola* (Kirby) within the same subgenus. In contrast, the subgenus *Separatobombus* Frison contains only three North American species, each as well separated from one species as from the other.

4. Characterization of Sectional and Subgeneric Names

The erection and use by myself of one new sectional and five new subgeneric names demands a definite characterization of these names. A few comments concerning the other sectional and subgeneric names of Vogt, Ball, Krüger, and Skorikov are given to aid other American students of bees in properly associating the American species belonging to these groups. The papers of Vogt and Krüger were published in German, that of Ball in French, and those of Skorikov in Russian.

In 1922, when working upon the subgeneric arrangement of the North American bumblebees I was unaware of Skorikov's most important paper published in the Russian language in 1922. I therefore proceeded to erect in manuscript seven new subgeneric names for the reception of various species of *Bremus* and *Psithyrus* not belonging to subgenera already established by European students of these bees. A short time later Skorikov's paper came to my attention and I found that since he had proposed new generic or subgeneric names for some of the same complexes the necessity for erecting most of these new subgenera no longer existed. It was an interesting bit of coincidence that two of my manuscript names were identical with those assigned the same subgenera by Skorikov.

Genus **BREMUS** Jurine (1801)[1]

Bremus terrestris (Linnaeus), a species occurring in Eurasia, is the type of the genus (Type by subsequent designation of Latreille, 1810).

[1] The use of the generic name *Bremus* Jurine, instead of *Bombus* Latreille, for the true bumblebees depends upon the recognition and acceptance of the famous "Erlangen List" printed in Erlangen in May, 1801. The validity of this "List" as constituting publication is questioned by many and the case is now before the International Commission of Zoological Nomenclature. Pending the decision of the Commission, the name *Bremus* is used in accordance with my adoption of it in 1919.

Section *Boopobombus* new sectional name

Males in all species with eyes conspicuously swollen and bulging from sides of head, except *B. rufocinctus* which has eyes but slightly swollen and bulging from sides of head; volsellae of genitalia protruding noticeably beyond squamae; malar space in some species reduced almost to a mere transverse line, and never over one-half as long as width at articulation of mandible; ocelli large and placed well down on the front, except *B. rufocinctus* which has ocelli of medium size situated just below supra-orbital line. Females with large ocelli placed well below supra-orbital line on narrowest part of front, except *B. rufocinctus* which has ocelli of medium size placed just below supra-orbital line; third antennal segment much longer than fifth and, depending upon the species, varying from almost as long to longer than the length of the fourth and fifth antennal segments combined; mesobasitarsus and metabasitarsus without pronounced projection at posterior apical angles of basitarsi.

I include in this section the North American species belonging to the subgenera *Fraternobombus* Skorikov, *Nevadensibombus* Skorikov, *Separatobombus* Frison, and *Cullumanobombus* Vogt. As will be noted from my characterization of this section, *B. rufocinctus* (Cress.) is transitional in many respects towards other sections. It seems to me that it should be placed here, however, upon the basis of several of its characters. Otherwise, a new section must be created for the reception of this species. This does not seem necessary or desirable.

Subgenus **Fraternobombus** Skorikov

In part, characterized by Franklin (1913) in his description of the *Fraternus* group. Skorikov (1922) proposed this name for a subgenus containing the North American species *B. fraternus* (F.Sm.) and two supposedly very closely related species from Central and South America. Together with certain other subgenera, this subgenus was placed in the genus *Alpigenobombus* Skorikov. As I have pointed out elsewhere, I do not accept Skorikov's division of the true bumblebess into nineteen separate genera in addition to numerous subgenera. Instead, I believe that all of the North American forms, if not the entire bumblebee fauna of the world, is adequately treated by the

recognition of Krüger's two sectional names, the additional one proposed in this paper, and homogeneous subgenera. Skorikov's subgeneric name of *Fraternobombus* is, nevertheless, still available for use and is accordingly accepted in this paper. Since Skorikov has not given a diagnosis of the characters presented by this subgenus they are presented here and based upon the type of the subgenus.

Male:—Ocelli more than the length of the third and fourth antennal segments together cephalad of a line between compound eyes at their most caudal points (supra-orbital line); eyes conspicuously bulging out from the sides of the head; articulation of the mandibles almost contiguous with the lower edge of the eyes, malar space therefore reduced to a mere transverse line; posterior metabasitarsus about four times as long as greatest width; outer spatha large, somewhat quadrangular, with a large median, semicircular notch on caudal margin; claspers larger than in any other North American species, vosellae extending well beyond squamae and somewhat pointed at tip, heads of sagittae broad, sickle-shaped, the caudo-dorsal portion bearing a projection which extends backward. Female:—Ocelli the length of the third antennal segment cephalad of a line between compound eyes at their most caudal points (supra-orbital line).

In figure 7 is shown the male genitalia of *B. fraternus* (F. Sm.), the only North American species belonging to this subgenus.

Bremus fraternus (F. Sm.), of North America, is the type of this subgenus (Type by absolute tautonymy).

Subgenus **Nevadensibombus** ~~Skorikov (1922)~~ / Bombias

Equivalent to the *Auricomus* Group of Franklin (1913) and adequately defined by him. It is rather unfortunate that Skorikov (1922) has given this division of bumblebees the generic name of *Nevadensibombus*, in view of the fact that Franklin called them the "*Auricomus* Group." The writer in manuscript, in 1923, assigned to this division a subgeneric name in harmony with Franklin's designation, but the appearance of Skorikov's paper (not available to the author in 1923) necessitates the use of Skorikov's name. It shoud be mentioned that Skorikov proposed *Nevadensibombus* as a generic name, but I recognize it as only of subgeneric status.

In figure 6 is shown the male genitalia of *B. auricomus* (Robt.) which is characteristic of the type of genitalia found in this subgenus. Only two North American species belong to this subgenus, *B. nevadensis* (Cress.) and *B. auricomus* (Robt.).

Bremus nevadensis (Cress.), of western North America, is the type of this subgenus (Type by absolute tautonymy).

Subgenus **Separatobombus** n. subgenus

Characterized in part by Franklin under his *Fraternus* Group. Skorikov placed the North American species now assigned to this subgenus in his subgenus *Alpigenobombus*, together with certain other species from Eurasia and Mexico. *Alpigenobombus* Skorikov, however, is not a natural grouping of all the species placed in it. I have studied all sexes of the eastern European *B. mastrucatus* (Gerst.) included in this subgenus by Skorikov, and it certainly can't be considered as subgenerically related to the North American species placed with it by Skorikov. The genitalia of the species under discussion show some similarities, but the presence of certain other pronounced structural characters indicates that they are not a natural group. Skorikov considers *B. alpigenus* (F. Mor.)—the type of his subgenus *Alpigenobombus* by absolute tautonymy—as a good species. Friese and Wagner (1910) consider *alpigenus* (F. Mor.) as a color variety of *B. mastrucatus* (Gerst.). Therefore, though I have not studied specimens of the former, it is a fairly safe assumption, based upon the close relationship of *alpigenus* (F. Mor.) and *mastrucatus* (Gerst.), that the characters of Skorikov's subgenus *Alpigenobombus* will not permit the inclusion of the North American species so placed by him. For this reason a new subgenus is proposed to include the North American species *B. separatus* (Cress.) and its varieties *mormonorum* (Frankl.) and *nero* Bequaert and Plath, *B. morrisoni* (Cress.), and *B. crotchii* (Cress.). The following characterization of this subgenus is given.

Male:—Ocelli about the length of the third antennal segment cephalad of a line between compound eyes at their most caudal points (supra-orbital line); eyes conspicuously bulging out from sides of the head; malar space almost as long as the fourth antennal segment; posterior metatarsus (metabasitarsus) about four times as long as greatest width; outer spatha rather deeply incurved on cephalic margin and caudal margin rather evenly incurved, not notched as in *B. fraternus* (F. Sm.); claspers with

vosellae extending well beyond squamae and terminating in a small outer pointed projection, heads of sagittae somewhat sickle-shaped and without a projection extending backward from caudal portion of heads. Female:—Ocelli about the length of the fourth antennal segment cephalad of a line between compound eyes at their most caudal points (supra-orbital line).

In figure 8 is shown the male genitalia of *B. separatus* (Cress.), which is characteristic of the general type found in this subgenus.

Bremus separatus (Cress.), of North America, is the type of this subgenus. (Present designation.)

Subgenus **Cullumanobombus** Vogt

Originally characterized by Vogt (1911), in part by Franklin (1913) under his *Fraternus* group, and by Krüger (1917, 1920). Skorikov (1922) places the North American species *B. rufocinctus* (Cress.) in this subgenus. Though I have not been able to study specimens of the rare *B. cullumanus* (Kirby) of Europe, I am convinced by a study of descriptions and figures of male genitalia that Skorikov was correct in his subgeneric assignment of *rufocinctus*, except that I consider *Cullumanobombus* as a subgenus rather than a genus as elevated by Skorikov.

In order to facilitate the recognition of this subgenus by American students, and to bring out the points of difference separating it from *Fraternobombus* Skorikov, *Nevadensibombus* Skorikov, and *Separatobombus* Frison, its distinguishing characters are here given.

Male:—Ocelli but slightly cephalad of a line between compound eyes at their most caudal points (supra-orbital line); eyes but slightly bulging out from the sides of the head; posterior metatarsus (metabasitarsus) about two and one-half times as long as broad; claspers with vosellae extending far beyond squamae and truncate on inner apical margin, squamae considerably reduced in size and broader than long, heads of sagittae sickle-shaped and with inward directed tips slender and rather pointed. Female:—Ocelli just cephalad of a line between compound eyes at their most caudal points (supra-orbital line).

In figure 9 is shown the male genitalia of *B. rufocinctus* (Cress.), which is fairly characteristic of the general type found in this subgenus. It is the only North American species belonging to this subgenus. Since it is probably the most variable species of North American bumblebee (from the standpoint of

color characters), I think that the following varieties justify recognition: *iridis* (Ckll. & Porter), *prunellae* (Ckll. & Porter), *albertensis* (Ckll.), and *sladeni* Frison.

Bremus cullumanus (Kirby), of Europe, is the type of this subgenus (Type by absolute tautonymy).

Section *Anodontobombus* Krüger

This section was proposed by Krüger (1917, 1920) for the reception of the Central European species of bumblebees of the subgenera *Alpinobombus* Krüger, *Mendacibombus* Krüger, *Confusibombus* Ball, *Lapidariobombus* Vogt, *Cullumanobombus* Vogt, *Soröensibombus* Vogt, *Pratobombus* Vogt, *Terrestribombus* Vogt, and *Mastrucatobombus* Krüger. It has been well characterized by Krüger and according to my studies includes the North American species belonging to the subgenera *Terrestribombus* Vogt, *Pratobombus* Vogt, and *Alpinobombus* Krüger.

korikov

orikov

Subgenus **Alpinobombus** Krüger

This subgenus is equivalent to the *Kirbyellus* Group of Franklin (1913), and has been previously well characterized by Vogt (1911), Franklin (1913), and Krüger (1920). Skorikov (1922) treated the species placed here as a genus instead of a subgenus. The bumblebees belonging here have the most northern distribution of all the various subgenera.

In figure 2 is shown the male genitalia of *B. hyperboreus* (Schönh.), which is characteristic of the general type of genitalia found in this subgenus. To this subgenus belong the following North American species: *B. hyperboreus* (Schönh.), *B. kirbyellus* (Curtis) and its varieties *arizonensis* Frison and *alexanderi* Frison, *B. kincaidii* (Ckll.), *B. strenuus* (Cress.), *B. polaris* (Curtis), and *B. neoboreus* (Sladen).

Bremus alpinus (Linn.), of Europe, is the type of the subgenus (Type by absolute tautonymy).

Subgenus **Terrestribombus** Vogt

This subgenus is equivalent to the *Terrestris* Group of Radoszkowski (1884), and several North American species were placed in this group by Franklin (1913). It has been well characterized by Vogt (1911), Franklin (1913), and Krüger (1920).

In figure 1 is shown the genitalia of *B. terricola* (Kirby) which is characteristic of the general type of genitalia found in this subgenus. To this subgenus belong the following North American species: *B. moderatus* (Cress.), *B. occidentalis* (Greene) and its varieties *proximus* (Cress.) and *nigroscutatus* (Frankl.), *B. franklini* Frison, *B. terricola* (Kirby) and variety *severini* Frison, and *B. affinis* (Cress.) and its variety *novae-angliae* (Bequaert).

Bremus terrestris (Linn.), of Europe, is the type of the subgenus (Type by absolute tautonymy).

Subgenus **Pratobombus** Vogt

Identical with the *Pratorum* Group of Radoszkowski (1884) and this Group as recognized by Franklin (1913). It has been well characterized by Vogt (1911), Franklin (1913), and Krüger (1920). This subgenus contains the largest number of species of any subgenus. In North America this subgenus tends to break up into several smaller complexes.

In figure 4 is shown the male genitalia of *B. ternarius* (Say), which is characteristic of the general type of genitalia found in this subgenus. To this subgenus belong the following species of America north of Mexico:

B. ridingsii (Cress.) and varieties *bimaculatus* (Cress.), *ahenus* Bequaert and Plath and *arboreti* Bequaert and Plath; *B. impatiens* (Cress.); *B. ternarius* (Say) and variety *expallidus* (Ckll.); *B. huntii* (Greene) and variety *rufosuffusus* (Ckll.); *B. edwardsii* (Cress.); *B. vosnesenskii* (Rad.); *B. bifarius* (Cress.) and varieties *vancouverensis* (Cress.), *kenoyeri* (Ckll.) and *nearcticus* (Handl.); *B. sylvicola* (Kirby) and varieties *lutzi* Frison, *johanseni* (Sladen) and *gelidus* (Cress.); *B. melanopygus* (Nyl.) and variety *washingtonensis* Frison; *B. sitkensis* (Nyl.); *B. mixtus* (Cress.); *B. frigidus* (F. Sm.); *B. couperi* (Cress.); *B. alboanalis* (Frankl.); *B. perplexus* (Cress.); *B. vagans* (F. Sm.), subspecies *sandersoni* (Frankl.) and variety *coctus* Bequaert and Plath; *B. cockerelli* (Frankl.); *B. bolsteri* (Frankl.); *B. pleuralis* (Nyl.) and variety *clarus* Frison; *B. flavifrons* (Cress.) and varieties *dimidiatus* (Ashmead) and *ambiguus* (Frankl.); *B. centralis* (Cress.) and variety *monardae* (Ckll. and Porter).

/bimaculatus, ridingsii

Bremus pratorum (Linn.), of Europe, is the type of the subgenus (Type by absolute tautonymy.)

Section *Odontobombus* Krüger

This section was erected by Krüger (1917, 1920) for the reception of the Central European species of bumblebees of the subgenera *Hortobombus* Vogt, *Subterraneobombus* Vogt, *Pomobombus* Vogt, and *Agrobombus* Vogt. It has been well characterized by him and according to my studies includes the North American species belonging to *Subterraneobombus* Vogt and *Fervidobombus* Skorikov.

Subgenus **Subterraneobombus** Vogt

Equivalent to the *Borealis* Group of Franklin (1913), and previously well characterized by Franklin (1913), Vogt (1911), and Krüger (1920). Treated by Skorikov (1922) as a genus.

Figure 3 shows genitalia of *B. borealis* (Kirby) which is quite characteristic of the genitalia of the members of this subgenus. To this subgenus belong two North American species: *B. borealis* (Kirby) and *B. appositus* (Cress.).

Bremus subterraneus (Linn.), of Europe, is the type of this subgenus (Type by absolute tautonymy).

Subgenus **Fervidobombus** Skorikov

This is equivalent to the *Dumoucheli* Groups of Radoszkowski (1884) as adopted and further characterized by Franklin. The species belonging here were treated by Skorikov (1922) as a genus. As elsewhere, I consider this group as being of subgeneric status.

Since Franklin (1913) had correctly assigned the members of this subgeneric complex in America to the *Dumoucheli* Group of Radoszkowski (1884), it is unfortunate that Skorikov (1922) has established the generic name *Fervidobombus* for the species belonging here. This is all the more unfortunate because of the erection of a *Fervidus* Group by Radoszkowski (1884) for the reception of a group of species (*Subterraneobombus* Vogt) to which *B. fervidus* (Fabr.) does not belong. Radoszkowski misidentified *B. borealis* (Kirby) as *B. fervidus* (Fabr.).

In figure 5 is shown the male genitalia of *B. americanorum* (Fabr.) which is characteristic of the general type of genitalia found in this subgenus. To this subgenus belong the following species of America north of Mexico: *B. fervidus* (Fabr.) and var. *dorsalis* (Cress.), *B. californicus* (F. Sm.) and its varieties *dubius* (Cress.) and *consanguineus* (Handl.), *B. americanorum* (Fabr.), and *B. sonorus* (Say) and var. *flavodorsalis* (Frankl.).

Bremus fervidus (Fabr.), of North America, is the type of this genus (Type by absolute tautonymy).

Genus **PSITHYRUS** Lepeletier (1832)

Psithyrus rupestris (Fabricius), of Europe, is the type of the genus (Type by subsequent designation of ~~Franklin, 1913~~). /Bingham 1897/

The genus *Psithyrus* has not been heretofore divided into subgenera, but for the sake of the uniformity of the classification of this family as a whole this genus should be subjected to the same subgeneric treatment as *Bremus*. Accordingly, three new subgenera are erected for the American species. In order to be consistent, the proposed subgeneric names have been formed as in the genus *Bremus*. While some of the resulting combinations are rather long, it seems best not to disrupt a system started and followed by many since 1911. In justice to the previous work of Franklin (1913), it should be stated that these three new subgenera of *Psithyrus* were first recognized by him as Groups. Some of the Eurasian species of *Psithyrus* are referable to these new subgenera, but new names must be proposed for others.

Subgenus **Laboriopsithyrus** new subgenus

Equivalent to the *Laboriosus* Group of Franklin (1913) and well characterized by him.

In figure 10 is shown the male genitalia of *Psithyrus laboriosus* (Fabr.) which is characteristic of the general type of genitalia found in this subgenus. To this subgenus belong the following North American species: *Psithyrus laboriosus* (Fabr.) and var. *citrinus* (F. Sm.), *P. insularis* (F. Sm.), *P. variabilis* (Cress.) and var. *bicolor* Frankl., and *P. crawfordi* Frankl.

Psithyrus laboriosus (Fabr.), of North America, is the type of this subgenus (Original designation).

Subgenus **Ashtonipsithyrus** new subgenus

Equivalent to the *Ashtoni* Group of Franklin (1913) and well characterized by him.

In figure 11 is shown the male genitalia of *Psithyrus ashtoni* (Cress.) which is characteristic of the general type of genitalia found in this subgenus. Only two North American species belong to this subgenus: *Psithyrus ashtoni* (Cress.) and *Psithyrus suckleyi* (Greene).

Psithyrus ashtoni (Cress.), of North America, is the type of this subgenus (Original designation).

Subgenus **Fernaldaepsithyrus** new subgenus

Equivalent to the *Fernaldae* Group of Franklin (1913) and well characterized by him.

In figure 12 is shown the male genitalia of *Psithyrus fernaldae* Franklin which is characteristic of the general type of genitalia found in this subgenus. To this subgenus belongs the North American species *Psithyrus fernaldae* Franklin and its variety *wheeleri* Bequaert and Plath.

Psithyrus fernaldae Franklin, of North America, is the type of this subgenus (Original designation).

III. Proof of the Naturalness of this Classification

Since the classification of the Bremidae of America north of Mexico has now been presented, it is not out of place to briefly discuss here whether such a morphological classification is substantiated by the biology of bumblebees; in other words whether this classification, based on morphological characters, is a natural classification. A mass of mostly unpublished data giving detailed information about many phases of the biology and behavior of bumblebees has been accumulated by the writer since 1910. This cannot in its entirety be introduced here, but some of the generalizations deducible from these data must need be drawn upon to substantiate my contention that the classification just outlined and partially proposed is a natural one.

The Bremidae as already indicated are divisible into two well-defined genera, *Bremus* and *Psithyrus*. These two divisions are sharply separated structurally, and studies of *Bremus* and *Psithyrus* in all parts of their range provide ample proof that these two genera also differ biologically. We may say that from the standpoint of structure the females of *Psithyrus* are degenerate *Bremus*, and from the standpoint of biology that they are specialized *Bremus*. The females of *Psithyrus* have lost certain structures possessed by bumblebees which are necessary for the independent rearing of brood, and are dependent upon *Bremus* in whose colonies they live as inquilines or social parasites. Queens of *Bremus*, however, mostly live an independent life (at

least independent in the true sense of social parasitism) and are capable of founding and furthering the development of colonies. Accordingly, the generic separation of *Psithyrus* and *Bremus* is justified on the basis of bionomics as well as on the evidence afforded by structure.

Granting the validity of considering the true and false bumblebees as two separate genera, the question may be raised as to whether we are correct in considering the genus *Psithyrus* as the nearest affinity of the genus *Bremus*. Many writers, as Friese (1899), Sladen (1912), Lutz (1916), and Wheeler (1919), have considered *Psithyrus* as a direct offshoot of the bumblebee type. This is also the opinion of the writer. Structurally, the closeness of relationship is evident. The fact that *Psithyrus* lives at the expense of *Bremus* is not conclusive proof of their affinity, since many insects do so which are very remotely separated from their present host. The habits of *Psithyrus*, however, dispose of such an objection as this. The female *Psithyrus* is almost a mimic of a large female queen of *Bremus*. She makes egg cells out of the same material as do the bumblebees, lays eggs in the same manner and broods on them. The immature stages are very similar to those of *Bremus*, develop in the same way, the larvae spin cocoons and the adults cut their own way out of the cocoons. Small females of *Psithyrus* are often produced and these might be considered as really equivalent to the small females or workers of *Bremus*. Mating takes place in much the same manner, and the fertilized females hibernate and lay eggs in colonies of bumblebees the following summer. The important biological differences between *Psithyrus* and *Bremus* are that females of *Psithyrus* universally invade the nests of *Bremus* and do not collect pollen and nectar for the rearing of their young. These habits are correlated with their loss of the pollen-baskets for the gathering of pollen. Even though the integument of *Psithyrus* females has become more heavily chitinized than that of the true bumblebees, the females, as I have found, have not entirely lost the ability to produce wax, a characteristic of the social bees. This, in itself, is a very important phylogenetic character and a strong argument in support of the evolution of *Psithyrus* from a bumblebee-like form. In other words, though the various species of *Psithyrus* have lost the art of pollen-gathering there is still a vestigial production of wax, a material which

is important to *Bremus* in its nest economy but which might have been entirely dispensed with in the case of *Psithyrus*. Summarizing, *Bremus* and *Psithyrus* are much more closely related to one another than to any other members of the Apoidea and their inclusion in the same family is justified.

To further strengthen our case it should be mentioned that in *Bremus* we find many traces of the habits that predominate in *Psithyrus*. Overwintering females (queens), of the same species of *Bremus*, frequently fight for the possession of the same nest either before or after the comb is started. More startling still is the fact that I once found a nest of *B. separatus* (Cress.) which had been invaded by a queen of *B. americanorum* (Fabr.), the queen of the former having been killed and the queen of the latter ruling the nest. The habits of *Psithyrus* are scarcely different from these and such fighting over nests is a psychological indication of the origin of *Psithyrus*. In view of the habits of *Psithyrus* and *Bremus*, it seems that we are undoubtedly presented with sufficient evidence to support the contention that *Psithyrus* has directly evolved from a bumblebee-like ancestor which was not greatly different from certain forms familiar today, particularly those of the section *Odontobombus*.

Recently Plath (1922) has advanced the idea that "an independent origin of at least three *Psithyrus* groups" is indicated. It seems to me, that the morphological features of the various species of North American bees of this genus show conclusively that such an independent origin has not occurred more than three times; namely, in the subgenera *Ashtonipsithyrus* Frison, *Laboriopsithyrus* Frison, and *Fernaldaepsithyrus* Frison. I am even inclined to doubt that three independent origins have occurred, in view of the fact that the subgenera of *Psithyrus* involved are not farther separated from one another biologically or structurally than are the various subgenera of *Bremus*. To admit the independent origin of three subgenera of *Psithyrus* forces one to admit many independent origins for the various subgenera of *Bremus* found today.

In another paper Bequaert and Plath (1925) record some very interesting observations regarding a possible different host fidelity by the species *Psithyrus laboriosus* (Fabr.) and its variety *citrinus* (Smith). If this is definitely established by additional

observations, a plausible theory is available to explain the development from a common ancestor of at least all species found today of any given subgenus of *Psithyrus*. Furthermore, arguments might be advanced to show that the same theory might be stretched to account for the evolution of all the subgenera of the genus *Psithyrus*. Certainly the evidence of morphology is not hostile to the acceptance of a common ancestry for the various subgenera of *Psithyrus*. If there has not been a common ancestry for such forms, then parallelism of evolutionary forms has here been brought about to a remarkable degree.

Before entering into a discussion of the relationships of the subgenera and sections, attention must be directed to the species. That the present system of specific classification of the Bremidae is a natural one is shown by my biological studies of the Illinois species. Detailed studies have shown that all of the Illinois species of bumblebees which are considered structurally distinct enough to merit their being called species, within the limits of reasonable minor individual differences largely influenced by their environment, are also distinct biologically and psychologically. Though *B. fervidus* (Fabr.) is very closely related to *B. americanorum* (Fabr.), as shown by its habits and structure, it nevertheless displays behaviorisms which are different from those of *B. americanorum* (Fabr.). The same condition is found among other closely related species. Take for instance *B. impatiens* (Cress.) and *B. bimaculatus* (Cress.). These two species clearly belong to the same subgenus and biologically in certain respects they are similar. In other ways they are so dissimilar in their habits that when once understood no one would ever think of considering them as a single species. Just as soon as the general biology of the bumblebees of all geographic areas is thoroughly understood, then will our haziness concerning the true status of many of our systematic varieties and subspecies be largely clarified. It suffices here to state that from the standpoint of biology none of the Illinois species of bumblebees are ranked too highly, their differences in behavior being as distinctive as are their differences in structure. This knowledge has been very useful in serving as a guide for the proper placement or rating of the other species of bumblebees considered in this article.

When we come to study the subgenera we are even more impressed with the agreement between our present morphological classification and a strictly natural grouping of the various species involved. In weighing biological evidence considerable discrimination must be used to avoid placing too much importance upon those behaviorisms which are more or less specific or individualistic. Here again I may cite an instance in point. The queens of *B. fervidus* (Fabr.) first appear after hibernating in the vicinity of Urbana at a later date than those of *B. americanorum* (Fabr.). Such a difference in time of appearance may often be more or less modified by environmental conditions and not be apparent during a late spring. No change in environmental conditions is great enough, however, to cause *B. americanorum* (Fabr.) and *B. fervidus* (Fabr.) suddenly to cease making small wax-pollen pockets on the sides of small larval masses or to cause a species such as *B. bimaculatus* (Cress.), which does not have such a habit, to assume it. Accordingly, our attention must be focused on biological characters which cannot be explained in terms of favorable or unfavorable conditions, etc. There are certain fundamental differences in the biology and nesting habits of bumblebees, evidenced by a mass of mostly unpublished data, which strongly indicate that our present structural subgeneric classification is a natural classification. Accordingly, the male genitalia of bumblebees offer us a reliable guide to subgenera, to phylogeny within the subgenera, and also afford clues as to the main outlines of the biology of the species which have not been studied. When we leave the subgeneric limits, however, and consider the higher categories of classification, the value of the male genitalia as reliable indexes of phylogeny becomes almost intangible and a classification based on their form would be as unnatural as it would be bizarre.

We now come to a consideration of the higher groups which are above subgenera and within generic limits. The true bumblebees, *Bremus*, have been divided by Robertson (1903), as previously stated, on the basis of structural characters into two genera, *Bombus* and *Bombias*. More recently Krüger (1917–1920) has divided *Bremus* into two sections called *Odontobombus* and *Anodontobombus*. This latter classification is also based upon structural characters, but Krüger calls attention to the fact that his

classification is supported by the biological classification of Sladen (1912). The biological classification of Sladen has to do with the grouping of the British species of bumblebees into the "Pollen-storers" and the "Pocket-makers," the latter being divisible into two subgroups called the "Pollen-Primers" and the "Carder-Bees." All classifications based upon color characters are valueless as a reliable means of interpreting the phylogeny or relationships of bumblebees and such characters are not taken into consideration in this discussion. It is true, however, that species with somewhat similar color patterns often belong to the same subgenus, for example, *B. appositus* (Cress.) and *B. borealis* (Kirby), but enough exceptions occur to invalidate its sole use as a means of showing relationships. The bumblebees of Illinois or of North America may be divided according to the structural classification of Robertson, that of Krüger, or according to the biological classification of Sladen. No matter which of the two structural classifications we adopt, we are confronted with several forms which are somewhat transitional in character.

In an earlier part of this paper I have stated my reasons for the recognition of three sections within the genus *Bremus*, *Odontobombus* Krüger, *Anodontobombus* Krüger, and *Boopobombus* Frison, which are based upon a combination of the structural classifications of Krüger and Robertson. Since Krüger's classification is supported by the biological classification of Sladen and since Robertson's system likewise contains elements of biological support, the combination of these classifications if properly conceived should present us with a classification which is satisfactory to the taxonomist as well as to the biologist. Naturally, because of the character of past studies the evidence furnished by systematic studies is the most complete. Though much biological information is still needed, particularly of western and northern species, the information that has been obtained concerning the biology of various subgenera indicates that the three sections which I have adopted are substantiated from a biological as well as from a structural point of view. Therefore, the classification, in its main features, of the bumblebees of America north of Mexico proposed in this paper seems to me to be a natural one.

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Explanation of Plates

PLATE XVI

Fig. 1.—Male genitalia of *Bremus terricola*, representative of the subgenus *Terrestribombus* Vogt.

Fig. 2.—Male genitalia of *Bremus hyperboreus*, representative of the subgenus *Alpinobombus* Krüger.

Fig. 3.—Male genitalia of *Bremus borealis*, representative of the subgenus *Subterraneobombus* Vogt.

Fig. 4.—Male genitalia of *Bremus ternarius*, representative of the subgenus *Pratobombus* Vogt.

Fig. 5.—Male genitalia of *Bremus americanorum*, representative of the subgenus *Fervidobombus* Skorikov.

Fig. 6.—Male genitalia of *Bremus auricomus*, representative of the subgenus *Nevadensibombus* Skorikov.

PLATE XVII

Fig. 7.—Male genitalia of *Bremus fraternus*, representative of the subgenus *Fraternobombus* Skorikov.

Fig. 8.—Male genitalia of *Bremus separatus*, representative of the subgenus *Separatobombus* Frison.

Fig. 9.—Male genitalia of *Bremus rufocinctus*, representative of the subgenus *Rufocinctobombus* Frison.

Fig. 10.—Male genitalia of *Psithyrus laboriosus*, representative of the subgenus *Laboriopsithyrus* Frison.

Fig. 11.—Male genitalia of *Psithyrus ashtoni*, representative of the subgenus *Ashtonipsithyrus* Frison.

Fig. 12.—Male genitalia of *Psithyrus fernaldae*, representative of the subgenus *Fernaldaepsithyrus* Frison.

Figure 1

Figure 2

Figure 3

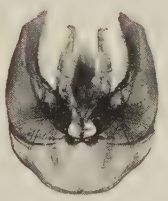

Figure 4

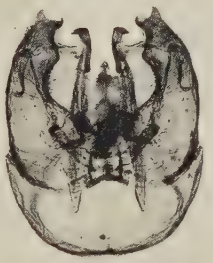

Figure 5

Figure 6

FRISON—BREMIDAE OF NORTH AMERICA

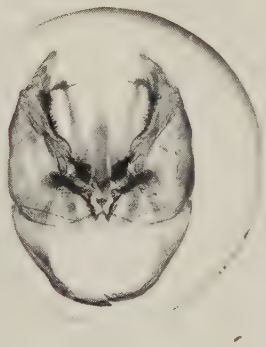

Figure 7

Figure 8

Figure 9

Figure 10

Figure 11

Figure 12

FRISON—BREMIDAE OF NORTH AMERICA

STUDIES IN THE TETTIGONIIDAE OF PANAMA (ORTHOPTERA)

BY MORGAN HEBARD

The material we record in the following pages is largely from the Canal Zone, and collections from the eastern and western extremities of the country, particularly covering the range in altitude there found, would certainly increase greatly the number of species of katydids to be included in the Panamanian list.

Two interesting small collections of Orthoptera have been received since the publication of our fifth contribution on the Dermaptera and Orthoptera of Panama.[1] One of these was secured by Dr. J. Chester Bradley, the other by Mr. Nathan Banks, the greater portion of each coming from Barro Colorado Island, on Gatun Lake. A considerable portion of the former series is retained by the author, in return for a series of other species desired for the collections of Cornell University, the latter collection belonging to the Museum of Comparative Zoology.

Contemporary study of our Colombian Tettigoniidae has been of considerable value, though only in the Chocó of that country is a fauna encountered which is generally similar to that of the Canal Zone.

Including the eighty-one species here studied, we find that a total of one hundred and twenty-five species of the Tettigoniidae have been recorded from Panama. Twenty-one of the forty-four species not represented in our Panamanian series

[1] The previous publications are;

"A Contribution to the Knowledge of the Dermaptera of Panama," Trans. Amer. Ent. Soc., XLIII, pp. 301 to 334, (1917).

"The Blattidae of Panama," Mem. Amer. Ent. Soc., No. 4, pp. 1 to 148, (1920).

"A Note on Panamanian Blattidae, with the Description of a New Genus and two New Species," Ent. News, XXXII, pp. 161 to 169, (1921).

"Studies in the Mantidae and Phasmidae of Panama (Orthoptera)," Trans. Amer. Ent. Soc., XLVIII, pp. 327 to 362, (1923).

"Studies in the Acrididae of Panama (Orthoptera)," Trans. Amer. Ent. Soc., L, pp. 75 to 140, (1924).

are to be found in the Philadelphia collections, leaving twenty-three species known from Panama which we have not been able to examine.

The following list gives, in systematic sequence, the species known from Panama; those which we have seen only from other than this region being preceded by an asterisk and those which we have not seen by a zero. The five hundred and thirty-one specimens treated represent eighty one species, among which we find one geographic race, eighteen species and five genera to be new.

PHANEROPTERINAE

		Page
**Dysonia fuscifrons* (Brunner)	Bugaba	
°*Markia hystrix* (Westwood)	Chiriqui	
Aegimia elongata Rehn		84
Dolichocercus latipennis (Brunner)		84
Insara bolivari (Griffini)		84
Phaneroptera paronae (Griffini)		85
Galu· ia reduc'a new species		87
Ceraia peraccae Griffini		88
Vellea cruenta (Burmeister)		88
Harroweria gloriosa new species		89
Chloroscirtus discocercus Rehn		91
**Ectemna dumicola* Saussure and Pictet	Bugaba	
°*Scaphura velutina* Kirby	Chiriqui[2]	
Stilpnochlora quadrata (Scudder)		91
Peucestes dentatus Stål		92
**Eupeucestes crassifolius* (Haan)[3]	Panama	
Posidippus validus Saussure and Pictet		92
Cnemidophyllum eximium new species		92
Orophus tessellatus Saussure		94
Orophus conspersus (Brunner)		95
Montezumina oblongoculata mesembrina new subspecies		96
Montezumina bradleyi new species		97
Anaulacomera crassidentata new species		99
Anaulacomera laticauda Brunner[4]		101

[2] In extensive collections now assembled we have no material of *Scaphura* from north of the Amazon, nor has any other record been given. The genus occurs widely over the southern portion of tropical South America and Brunner's specimen, described as *bicolor* and renamed *velutina* by Kirby, may very possibly been mislabelled.

[3] Recorded from Panama as the synonymous *Peucestes striolatus* Brunner by that author.

[4] *Anaulacomera lativertex* Brunner has also been recorded from Chiriqui, Panama. It appears, from study of our series, that that record may very possibly be based on slightly aberrant material of *laticauda*, such as we have here recorded from Panama.

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Anaulacomera uncinata new species 104
Anaulacomera alfaroi Rehn 106
Anaulacomera furcata Brunner 107
**Viadana azteca* (Saussure and Pictet) Bugaba and Chiriqui
Viadana zetterstedti (Stål) 108
**Hyperphrona irregularis* Brunner Chiriqui and Darien
°*Hyperphrona trimaculata* Brunner Bugaba and Chiriqui
Phylloptera dimidiata Brunner 109
Phylloptera panamae new species 109
Phylloptera festae Griffini 110
Itarissa costaricensis (Rehn) 111
Itarissa flavo-limbata (Brunner) 112
Pycnopalpa bicordata (Serville) 112
Microcentrum philammon Rehn 113
°*Microcentrum securiferum* Brunner Chiriqui
°*Microcentrum championi* Saussure and Pictet Bugaba
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°*Microcentrum punctifrons* Brunner . . Chiriqui[5]
°*Microcentrum colosseum* Brunner Bugaba
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Lamprophyllum bugabae new species 114
Philophyllia guttulata Stål 116

PSEUDOPHYLLINAE

Acanthodiphrus conspersus Walker 116
Championica montana Saussure and Pictet 117
**Orpacophora cristulata* (Brunner) Chiriqui
°*Haemodiasma tessellata* Brunner Chiriqui
Lichenochrus rehni new name 117
°*Lichenochrus muticus* Brunner Chiriqui
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[5] This record by Saussure and Pictet may very possibly represent a distinct, allied species. Such is certain for their record of *M. retinerve* (Burmeister) from Chiriqui, and extremely probable for that of *M. laurifolium* (Linnaeus) from the same locality.

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[6] Though we believe this species to be distinct from *D. salvifolius* (Lichtenstein), of which species we have specimens, we do not think that both species occur in Panama; such has been indicated by Saussure and Pictet, the latter incorrectly as *perspicillata* of Fabricius.

[7] We are convinced, from examination of Costa Rican material belonging to the Academy, that *siccifolia* Saussure and Pictet (*saussurei* Kirby), described from the Volcano of Chiriqui and Caldera, Panama, is a synonym of *viridifolia*, based on a brown color phase of the species.

[8] This record may very possibly be based on a color phase of *maxillosus*. The species, described by Redtenbacher as *Conocephalus frater*, appears, from the localities originally given, to be a composite.

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[9] We find Redtenbacher's *surinamensis* to be a synonym, from comparison of Guianan material with the original description and Stål's later description of the type of *tuberculatus*. It is, however, unlikely that Griffini's Panamanian material represents this species.

[10] From study of the literature and material before us it is evident that the tropical North American and northwestern South American *pretiosa* is distinct from tropical eastern South American *bisulca* (Serville) and that Brunner's and Saussure and Pictet's records of *bisulca* from Guatemala and Panama should be referred to *pretiosa*.

[11] See Hebard, Trans. Amer. Ent. Soc., LII, p. 345, (1926).

Two additional species of the Phaneropterinae are certain to be found in Panama, as *Euceraia insignis* Hebard is found from Nicaragua to Colombia and *Syntechna tarasca* (Saussure) from Mexico to Ecuador.

Phaneropterinae

Aegimia elongate Rehn

1903. *Aegimia elongata* Rehn, Trans. Amer. Ent. Soc., xxix, p. 19. [♂, Central America.]

Bugaba, Chiriqui, (W. Schaus), 1 ♀.

The female of this very remarkable species has not hitherto been recorded. It is much larger than the male, with very much broader tegmina, the ovipositor curved rather strongly and very evenly dorsad, of subequal width with apex rounded, armed distad with small, low, truncate teeth which are rectangular in form, its lateral surfaces polished and almost smooth.

A larger female from La Florida, Costa Rica, is in the Academy collection. These specimens measure as follows; length of body 40 and 44.3, dorsal length of produced facial fastigium 6.1 and 6.1, length of pronotum — and 9.3, caudal width of pronotal disk — and 7.3, length of tegmen 50.3 and 55, greatest (meso-distal) width of tegmen 27.2 and 31.2, length of caudal femur 19.5 and 23.8, median width of caudal tibia 6.1 and 6.8, length of ovipositor 10.3 and 11 mm.

Dolichocercus latipennis (Brunner)

1891. *Hormilia latipennis* Brunner, Addit. Monogr. der Phaneropt., p. 117. [♀; Chiriqui, Panama (not Costa Rica).]

Porto Bello, March 10, 1911, (A. Busck), 1 ♂.

This specimen was described and figured, a new genus being described for the species, by Rehn and Hebard.[12]

Insara bolivari (Griffini)

1896. *Hormilia bolivari* Griffini, Boll. Mus. Zool. Anat. Comp. Univ. Torino, xi, No. 232, p. 13. [♀; Colon, Darien (= Panama).]

Gatun, Canal Zone, (A. H. Jennings), 1 ♂; July 12 to August 22, 1916, (D. E. Harrower), 2 ♂, 16 ♀, 2 juv. ♂, (4 ♀ green color phase).

Frijoles, C. Z., June 10, 1924, (N. Banks), 1 ♀.

Gold Hill, C. Z., November 14, 1913, (M. Hebard; in dead leaves on ground, under vine-covered bushes), 1 ♀.

Paraiso, C. Z., April 3, 1911, (E. A. Schwarz), 1 ♀.

Corozal, C. Z., November 17, 1913, (M. Hebard; in dead leaves under brush, on edge of heavy forest), 1 small juv. ♂.

[12] Trans. Amer. Ent. Soc., xl, p. 40; p. 56, fig. 1; p. 57, fig. 23, (1914).

The green color phase of this species, like that of *I. intermedia* (Brunner), has the velvety brown abdominal marking in no way reduced. The tegmina are irregularly suffused and the antennae annulate with brown, these markings further readily distinguishing such specimens from those of the normally green species of the genus.

The extremes in the Gatun series are: length of tegmen ♂ 26.8 to 27.7, ♀ 24 to 26.3; length of caudal femur ♂ 22.7 to 23, ♀ 21.7 to 24.8 mm.

The species was discussed in detail and figured by Rehn and Hebard in 1914.[13] Its distribution is known to reach northward to Nicaragua.

The genus, as properly restricted, probably does not occur in South America.

Phaneroptera paronae (Griffini)

1896. *Scudderia paronae* Griffini, Boll. Mus. Zool. Anat. Comp. Univ. Torino, XI, No. 232, p. 11. [♂, juv. ♀; Colon, Darien (= Panama).]

David, Chiriqui, August 10, 1922, (D. E. Harrower), 1 ♂.

Gatun, Canal Zone, June, 1915 and July 12 to August 22, 1916, (D. E. Harrower), 5 ♂, 8 ♀, 2 juv. ♂, 8 juv. ♀, 1 very small juv.

Culebra, C. Z., 1910, (H. H. Rousseau), 1 ♂, 1 juv. ♂, 1 juv. ♀, [U.S.N.M.].

Paraiso, C. Z., January 28, 1911, (E. A. Schwarz), 1 ♀.

Ancon, C. Z., November 16, 1913, (M. Hebard; in tall grass of marshy spot at foot of hill), 1 ♂, 1 ♀, 1 juv. ♀.

In the early stages, the extremities of the caudal femora and all of the caudal tibiae and tarsi are usually blackish brown, the antennal annuli extremely striking and the green, yellow and reddish brown of the body and limbs very brilliant.

The species was discussed by Rehn and Hebard in 1914.[14] Its distribution northward is now known to extend as far as the states of Vera Cruz and Sinaloa, Mexico.

GATUNIA new genus

This genus is erected to include the Costa Rican *Turpilia linearis* Rehn and a closely related new species here described. They have the appearance of very slender forms of *Phaneroptera*, with very narrow tegmina and protruding eyes, but the different male genitalia, and particularly the presence of articulate

[13] Trans. Amer. Ent. Soc., XL, p. 60; p. 56, figs. 7 and 8.

[14] Trans. Amer. Ent. Soc., XL, p. 307.

styles on the subgenital plate, shows the affinity to be rather with *Ceraia*.

No other wholly green species, with wings delicately tinted with orange, are known to us from tropical America.

The genus runs nearest *Ligocatinus* Rehn, but plainly does not belong to that group, which further includes the genera *Parascudderia*, *Homotoicha* and *Theudoria*.

Genotype: *Gatunia reducta* here described.

The genus is best distinguished by the following characters. Cephalic coxae armed with a spine. Fastigium moderately convex, subsulcate dorsad, gradually and weakly deflexed to its bluntly rounded apex, which is briefly separated from the frontal costa. Male subgenital plate only moderately produced, moderately emarginate distad, bearing articulate styles. Cephalic tibiae dorsad sulcate and unarmed except for a disto-external spine,[15] auditory foramina apert. Tegmina narrow, with sutural margin straight; median vein branched distad, the branches running to the sutural margin. Caudal femora with ventral margins both spined and genicular lobes moderately bispinose. Pronotum with lateral lobes vertical and deeper than long, rounding bluntly into the disk. Male ultimate tergite simple, not produced. Male cerci simple, without appendages.

To explain Rehn's original assignment of *linearis* to *Turpilia* and Kirby's of that species to *Diplophyllus*, we give the following data.[16]

Material of the West Indian *punctata* Stål, type by monotypy of *Turpilia* Stål, is in the Academy collection. That species and others of the genus before us are seen to resemble *Microcentrum* closely in general appearance and particularly in tegminal form, the most striking difference being in the very narrow fastigium. As properly restricted, therefore, *Turpilia* is found to be a widely distinct genus, but at the time *linearis* was described, species of other genera had been there assigned, misleading Rehn.

The genus *Diplophyllus* Saussure was even more of a composite. We here select as genotype that author's Brazilian *ensifolius*.[17] That genus is also apparently Microcentroid, but we think it unlikely that *Turpilia* will be found a synonym, as has been

[15] With a median spine on one of the cephalic tibiae in the type of *reducta*.

[16] See also synonymy noted in our discussion of *Montezumina* on page —.

[17] Kirby's fixation of *Turpilia mexicana* Brunner in 1906 is invalid, that species not having been originally included in *Diplophyllus*.

indicated by Kirby. The latter, as recognized by that author, was dreadfully confused, for of the eighteen species he referred to *Diplophyllus* we have been able to assign definitely eleven, as follows; the genotype, three referable to *Montezumina*, three to *Turpilia*, and one each to *Anaulacomera*, *Gatunia*, *Phylloptera* and a yet undescribed genus. Kirby's difficulty is better understood when we realize that Saussure originally included in *Diplophyllus* eight species; the genotype, two now referred to *Anaulacomera*, two to *Phylloptera*, two to *Stilpnochlora* and one to *Syntechna*.

Gatunia reducta new species (Pl. XIX, figs. 1 and 2)

Though apparently specifically distinct from the Costa Rican *G. linearis* (Rehn) (see pl. XIX, fig. 3), this insect is sufficiently close to indicate a possibility that it may instead represent a geographic race.

The present male, compared with the male type of that species, differs in the decidedly shorter organs of flight and caudal limbs, the shallower lateral lobes of the pronotum and slight differences in the male subgenital plate and styles. In all other respects they are identical.

Type: ♂; Gatun, Canal Zone, Panama. July 19 to 22, 1916. (D. E. Harrower.) [Hebard Collection, Type No. 1058.]

In addition to the characters given in the generic description the following are noted. Size and form medium, surface shining. Apex of fastigium hardly two-fifths as wide as proximal antennal joint. Organs of flight elongate. Ultimate tergite short, dorsal portion of free margin broadly convex. Cerci short, cylindrical, tapering, moderately incurved, but with apex more slender and straight, terminating in a large, weakly curved tooth. Subgenital plate small, with lateral rounded carinae which converge gradually and are briefly produced, each surmounted by a small tapering style, distal margin subangulate U-emarginate.[18] Limbs elongate and slender, except proximal portions of caudal femora which are decidedly robust. Cephalic femora with two and median femora with one minute spines on ventrocephalic margins distad; genicular lobes blunt, with the vestiges of one or two minute spines. Caudal femora armed ventrad with (4 and 5 internal, 5 and 6 external) small spines; genicular lobes fairly strongly bispinose. Median tibiae sulcate dorsad, with caudal margin armed with (3 and 4) small spines.

[18] In *linearis* the distal portion of this plate is slightly heavier, the emargination more evenly U-shaped and the styles longer, cylindrical and not tapering to their rounded apices.

General coloration rivage green, the tegmina slightly darker but quite as richly colored. Tegmina with intervals between veinlets in stridulating field and those at and adjacent to sutural margin of discoidal field dark brown. Wings hyaline weakly tinged with orange, the veins pale orange, except area exposed when at rest, which is of the same green as the tegmina. Antennae, except proximad, and apices of spines on limbs, dark brown.

The major differences between this insect and *linearis* are shown by the following measurements (in millimeters).

♂	Length of body	Length of pronotum	Caudal width of pronotal disk	Depth of pronotal lateral lobes	Length of tegmen	Width of tegmen	Length of wing beyond tegmen	Length of caudal femur
G. reducta								
Type.....	16.8	4.2	3.2	3.3	29.8	4.8	4.8	21.2
G. linearis								
Type.....	16.5	4.4	3.3	3.7	33.5	5.8	6.5	22

The type is unique.

Ceraia peraccae Griffini

1896. *C[eraia] peraccae* Griffini, Boll. Mus. Zool. Anat. Comp. Univ. Torino, XI, No. 232, p. 10. [♂; Punta di Sabana, Darien.]

Barro Colorado Island, Canal Zone, July 28, 1924, (N. Banks), 1 ♂.

The black apices of the male cerci are a striking feature in this handsome species. The rounded socket about the cercal bases is blackish brown dorsad.

This specimen agrees closely with the original description, but has fewer spines on the dorso-caudal margins of the cephalic and median tibiae and is somewhat larger. Length of body 25.2, length of pronotum 7.6, length of tegmen 46.8, width of tegmen 10.8, length of caudal femur 34.8, length of subgenital plate 8.6 mm.

Vellea cruenta (Burmeister) (Pl. XVIII, fig. 1; pl. XIX, fig. 4)

1839. *Ph[aneroptera] cruenta* Burmeister, Handb. Ent., II, Abth. 2, pt. I, p. 691. [Rio de Janeiro, Brazil.]

Bocas del Toro, July 1 to 10, 1910, (Wirt Robinson), 2 ♂.

The proximal portions of the tegmina, including about three-fifths of the total area, are eugenia red, this extending further distad in the anterior field than elsewhere and margined with buffy distad and caudad.

This is the only American Phaneropterid with rich purplish pink wings. It is now known from Costa Rica to the Territory of Misiones, Argentina.

HARROWERIA[19] new genus

The coloration alone places this genus as the most brilliant known of the Tettigoniidae from the American tropics, the wings being largely metallic purple black, the insect marked with green, black, buff, ferruginous and cream white as described below. The antennae, with four heavily hirsute sections, are equally extraordinary. In *Scaphura* Kirby, alone of the described American genera, are the antennae heavily hirsute, but there only in the proximal portion.

The general size, form, shape of head and pronotum, armament of the limbs and female subgenital plate agree with *Ceraia* Brunner, the sutural margin of the tegmina showing a distinct oblique tendency distad as in *Euceraia* Hebard and *Vellea* Walker.

Other distinctive features are; the coriaceous tegmina with median vein branching strongly proximad (its branches running to the sutural margin as in Ceraia). The cephalic femora with ventro-caudal margin strongly lamellate produced. The ovipositor, curved moderately and rather evenly dorsad, tapering distad with even weak convexity to the acute median apex; its lateral surfaces rugulose, its margins in distal third armed with very minute recumbent teeth.

Genotype: *Harroweria gloriosa* here described.

The genus is apparently an extremely aberrant member of the Group Ceraiae. Discovery of the male sex is awaited with interest.

Harroweria gloriosa new species (Pl. XVIII, fig. 2)

This magnificent insect is one of the most brilliantly colored and distinctively specialized katydids we have ever seen.

Nearest approach in wing coloration is found in the tropical American Mantid genus *Angela*.

Type: ♀; Gatun, Canal Zone, Panama. August 6 to 21, 1916. (D. E. Harrower.) [Hebard Collection, Type No. 1046.]

[19] In honor of Mr. D. E. Harrower, who secured the unique example of this splendid genus and numerous other interesting species in Panama.

The following features are important, in addition to those given in the generic description. Size and form about as medium in *Ceraia*. Vertex coming to a blunt node before the antennal sockets, the fastigium then suddenly and sharply declivent to its minute rounded apex, which is medio-longitudinally carinate dorsad to near its extremity. In cephalic view the apex of the fastigium is minute, rounded, well separated from the facial fastigium and about one third as wide as the proximal antennal joint. Antennae with hirsute sections as follows; first weak, second elongate and prominent, third more elongate and very prominent, fourth shorter and not as heavy as second. Pronotum with sulci very deep, small but rather deep circular impressions on disk laterad and caudad of first sulcus, mesad on mesozona and meso-laterad at extremities of sulcus forming cephalic boundary of metazona. Lateral lobes of pronotum much deeper than wide, the humeral sinus deep but broadly rounded. Tegmina with numerous cross-veinlets in discoidal field; everywhere coriaceous, due to a close network of minute veinlets between the larger and more regular veins, which break its surface into a myriad of very minute areolets of generally the same size. Cephalic and median femora unarmed, caudal femora with ventral margins armed with (5 and 6 internal, 6 and 8 external) very small spines. Genicular lobes of femora bluntly rounded, those of the caudal femora bearing a minute spine ventrad. Cephalic femora with lamellation of ventro-caudal margin becoming stronger distad, there about two-thirds as wide as the limb, at the apex roundly subsiding. Cephalic tibiae with a single minute disto-external spine and on one with a still smaller external spine at the apex of the enlarged proximal portion. Subgenital plate extremely small, triangular. Mesosternal and metasternal lobes broadly rounded, little produced.

Head buffy with a very broad postocular bar and six vertical facial bands of blackish brown, as well as markings of the same on the labrum and clypeus. Hirsute portions of antenna and its base and apex black, the intervening portions ferruginous. Pronotal disk buffy, becoming chromium green laterad and broadly caudad on metazonal portion; tegmina with major veinlets of the mediastine and discoidal fields and all of the anal field of this color, in the latter becoming richer, shamrock green. Pronotal lateral lobes with very wide postocular bar largely chestnut brown deepening to blackish on its margins, as is a ventral marginal area, leaving only a moderately broad ventral band between; pleura and sides of abdomen marked with buff. Tegmina blackish brown, pale portions proximad green, as noted above, distad a pale brownish buff. Wings brilliant metallic purple black, except in distal portion of anterior field where there is first a very broad transverse band of creamy

white, followed by a still broader one of blackish brown, then a narrow band of pale brownish buff and a tip of blackish brown, this area is glossy but alone not metallic; the radiate veins proximad are very finely shamrock green. Ovipositor black, becoming russet only at apex. Caudal margins of abdominal tergites and pale areas of caudal femora proximad tinged with green, the more distal the more strongly. All tibiae ferruginous, median femora the same but slightly suffused, cephalic femora blackish brown paling to rufous in median portion throughout their length, slender distal and proximo-ventral portions of caudal femora dilute rufous.

Length of body 25, length of pronotum 5.1 caudal width of pronotal disk 4.3, depth of pronotal lateral lobe 4.8, length of tegmen 37.3, width of tegmen 7.9, length of caudal femur 23.2, length of ovipositor 12, median width of ovipositor 2.2 mm.

The unique type was taken flying in the dark recesses of a heavy forest.

Chloroscirtus discocercus Rehn

1918. *Chloroscirtus discocercus* Rehn, Trans. Amer. Ent. Soc., XLIV, p. 348, pl. 19, figs. 1 to 4. [♂; Cachi, Costa Rica.]

Barro Colorado Island, Canal Zone, March 26 to 31, 1924, (J. C. Bradley), 3 ♂.

Material of this interesting species is also in the Academy collection from Eden, Nicaragua, showing that it has a wide distribution in Central America.

Stilpnochlora quadrata (Scudder)

1869. *Steirodon quadratum* Scudder, Proc. Boston Soc. Nat. Hist., XII, p. 331. [♂; Guayaquil, Ecuador.]

Bocas del Toro, July 1 to 10, 1908, (Wirt Robinson), 1 ♀.
Porto Bello, August 18 to 21, 1916, (D. E. Harrower), 1 ♀.
Culebra, Canal Zone, January, 1911, (Dr. Pittier), 1 ♂, [U.S.N.M.].

This male shows closer resemblance to Cuban and Floridian males of *S. couloniana* (Saussure) than do Costa Rican males of *quadrata* before us, in the slightly shorter and weaker stridulating vein. These insects are very closely related and may eventually prove to be races of one species.[20]

Saussure and Pictet recorded this insect as *S. marginella* (Serville) from the Volcan de Chiriqui, Panama.

[20] See Rehn's discussion of the genus, Ent. News, XXVIII, p. 107, (1917).

Peucestes dentatus Stål

1874. *P[eucestes] dentatus* Stål, Recensio Orth., II, p. 45. [Panama; Cayenne (= French Guiana).]

Bocas del Toro, July 1 to 10, 1908, (Wirt Robinson), 1 ♂, 1 ♀.
Cristobal, Canal Zone, (J. E. Walker), 1 ♀, [A.N.S.P.].
Paraiso, C. Z., March 20, 1911, (E. A. Schwarz), 1 ♂.
Panama City, December 16, 1916, (J. Zetek), 1 ♀.
Porto Bello, February 18, 1911, (A. Busck), 1 ♀.
Pinogana, Darien, December, 1915, (Muñoz), 1 ♀.
Panama, 1 ♀, [Hebard Cln.].

Though Stål gave references to both Stoll and Blanchard under this species, we believe that Stoll's record of *citrifolia* (not of Linnaeus) should be placed instead under *P. crassifolius* (Haan).

Males of this species have been recorded from Panama and Cauca, Colombia, by Rehn. Costa Rican females[21] so recorded by that author are, however, referable to an undescribed species of *Steirodon* Serville. This confusion caused him to believe that the difference in tegminal venation described for these genera was of little or no value, whereas it actually constitutes an important character.

Posidippus[22] **validus** Saussure and Pictet

1898. *Posidippus validus* Saussure and Pictet, Biol. Cent.-Amer., Orth., I, p. 373, pl. 18, figs. 10 and 11. [♀; Chontales, Nicaragua.]

Tabernilla, Canal Zone, (A. Busck), 1 ♀.

The tegmina in this female measure in length 82.2, in width 27 mm.

Rehn has recorded a male of this species from Panama and a female from the Hacienda Cincinnati, Sierra San Lorenzo, Magdalena, Colombia.

Cnemidophyllum eximium new species (Pl. XIX, figs. 5 and 6)

Though much larger and more conspicuously marked, this insect is very closely related to *C. lineatum* (Brunner).[23] The

[21] The female recorded from Panama was secured by the Rev. T. Heyde. It was probably incorrectly labelled and we now have labelled it "Central America." This is as definite as is safe for any of the Bruner Collection material collected by Heyde.

[22] We have recently published a key to the genera of the Group Steirodontia, Trans. Amer. Ent. Soc., LII, p. 285, (1926).

[23] See Rehn, Ent. News, XXVIII, p. 119, pl. 10, figs. 5, 8 and 9, (1917).

present male is further distinguished by the heavier blunt dentation of the pronotal combs laterad, the very slightly broader pronotal lateral lobes, the heavier stridulating vein and tegmina which do not narrow as much distad, have the broad concavity of the sutural margin more decided and their distal obliquity much less gradual. Though the markings are much more prominent, this difference is seen to be probably largely due to intensification.

Type: ♀; Eden, Pis Pis District, Nicaragua. June and July, 1922. (T.W. Bouchelle.) [Acad. Nat. Sci. Phila., Type no. 5431.]

Size very large, form robust but graceful. Fastigium weakly sulcate proximad,[24] its apex rounded and nearly as wide as the proximal antennal joint, overhanging and in contact with the minute rounded apex of the facial fastigium. Pronotal disk produced dorso-laterad in blunt teeth, the three heaviest and most distinct mesad on the prozona. Entire metazonal portion of pronotal disk minutely microscopically granulated.[25] Tegmina narrower but with contour somewhat suggesting that of *Peucestes dentatus* Stål; median vein springing from near end of proximal two-fifths of discoidal vein, branching proximad, its branches running to the sutural margin; that margin showing distinct though broad concavity from apex of anal field to distal section where it curves toward and then becomes strongly oblique to the rounded apex. Tegmina well surpassed by the apices of the wings. Mesosternal lobes rounded trigonal, metasternal lobes rounded. Abdominal tergites acute-angulate produced meso-caudad, the two distal each produced in two elongate, lamellate acute triangular processes. Cerci elongate, tapering, moderately incurved. Ovipositor relatively small, hirsute, unarmed, widest mesad, apex sharply rounded. Subgenital plate small, roughly triangular, sulcate and cleft at apex. Cephalic and median femora with ventro-cephalic margins alone armed with (2 and 3) spines, caudal femora with both ventral margins spined, the external becoming moderately lamellate distad with (3) spines there considerably heavier; genicular lobes all bispinose. Proximal lamellate expansion of median and caudal tibiae sudden and very decided.

Allotype: ♂; Barro Colorado Island, Canal Zone, Panama. July 24, 1924. (N. Banks.) [Museum of Comparative Zoology.]

[24] Similar in the male, the specimen of that sex of *lineatum* before us with similar sulcation continued to near the apex of the fastigium.

[25] Similar in the male, weaker in the male of *lineatum* before us and in that specimen obsolete meso-cephalad.

Agrees with female except as follows. Pronotum with dorsolateral teeth proportionately slightly more prominent. Tegmina with stridulating area large, stridulating vein prominent. Genitalia much as in *lineatum*. Abdominal tergites triangularly produced meso-distad, the penultimate there weakly emarginate. Ultimate tergite briefly produced in two small rounded angles meso-distad, on each side of which there is a slightly broader rounded angulate emargination. Cerci simple, cylindrical, tapering, curving feebly dorsad but sharply so distad, so that the apical tooth is erect, not surpassing the penultimate tergite. Subgenital plate damaged.

General coloration light green, becoming buffy on head, pleura, abdomen and limbs, this possibly due partially to discoloration. The following striking areas of chestnut brown occur. Eyes, proximal antennal joints, apices of fastigia, most of labrum, dentations of pronotum narrowly dorsad and heavily laterad, proximal half of humeral trunk of tegmina, a large spot mesad on pleura and one above bases of caudal femora, apices of cephalic and median femora broadly, which covers most of the cephalic face of the former and extends down to the ventral margin at each tooth, all femora with a broad preapical annulus, all of cephalic and median tibiae except for a broad pale meso-distal annulus, caudal tibiae with broad apices and a very broad annulus beyond the enlarged proximal portion and all of tarsi.

Length of body ♂ 32.8, ♀ 43.5; length of pronotum ♂ 10.7, ♀ 12.8; greatest width between apices of pronotal combs ♂ 9.7, ♀ 11.8; length of tegmen ♂ 66, ♀ 85.7; greatest tegminal width ♂ 17, ♀ 26.3; width of tegminal stridulating field 9.1; length of stridulating vein 7.7; length of caudal femur ♂ 35.5, ♀ 40.3; width of swelling of median tibia ♂ 2.8, ♀ 3.1; width of swelling of caudal tibia ♂ 4.5, ♀ 5; length of ovipositor 9.8 mm.

This splendid insect is known from the described pair.

Orophus tessellatus Saussure

1861. *Phylloptera* (*Orophus*) *tessellata* Saussure, Rev. et Mag. de Zool., (2), XIII, p. 129. [Mexico.]

Bugaba, Chiriqui, (W. Schaus), 1 ♂, 2 ♀.

Chiriqui, (from Staudinger and Bang-Haas), 2 ♂, [Hebard Cln.].

Gatun, Canal Zone, July 17 to August 22, 1916, (D. E. Harrower), 21 ♂, 15 ♀, 2 juv. ♂, 1 juv. ♀.

Barro Colorado Island, C. Z., 1 ♀, [Mus. Comp. Zool.].

Porto Bello, February 27 and March 10, 1911, (A. Busck), 2 ♂.

In the Gatun series all are green except two light brown males and four dark brown females. The larger males show an average

greater tessellation, the three largest having the cephalic tibiae, except in enlarged portion, heavily marked with blackish brown.

Small individuals of this species are separated with difficulty from large examples of *O. conspersus* (Brunner). The broader convexity of the tegminal apices, narrower and usually more sulcate fastigium and average larger size distinguish *tessellatus*, now known from Mexico to Ecuador.

Orophus conspersus (Brunner)

1878. *A[nepsia] conspersa* Brunner, Monogr. der Phaneropt., p. 270. [♂, ♀; Chiriqui, Panama.]

Griffini's *tessellata obtusa*, described from Lake Pita and the Rio Cianati, Darien, is a synonym.

Bugaba, Chiriqui, (W. Schaus), 1 ♂.

Chiriqui, (from Staudinger and Bang-Haas), 1 ♂, [Hebard Cln.].

Gatun, Canal Zone, September 1 to 7, 1922, (D. E. Harrower), 1 ♂.

Gamboa, C. Z., July 9, 1924, (N. Banks), 1 ♂.

Guamina, Rio Chagres, March 5, 1922, (G. H. H. Tate), 3 ♂.

We believe that, though very close to *O. tessellatus* Saussure, the present insect represents a distinct species, rather than a phase or race, as has more than once been suggested.

Darien is the furthest known locality for the species toward South America, its distribution reaching northward to Mexico.

MONTEZUMINA Hebard

1925. *Montezumina* Hebard, Trans. Amer. Ent. Soc., LI. p. 296.

We have recently been able to secure additional data on the species which have been assigned to *Diplophyllus* Saussure and *Turpilia* Stål. It is now possible to state that the former probably, and the latter certainly, are Microcentroid genera, *Diplophyllus* probably confined to South America and *Turpilia* finding its most extensive and diversified development in the West Indies.

The confusion in these genera has resulted in the incorrect inclusion of numerous species, some of which we can now locate definitely. Thus *Turpilia subinermis* Caudell is a member of *Anaulacomera* Stål; *Diplophyllus grandis* Rehn is a synonym of *Phylloptera dimidiata* Brunner; *Diplophyllus linearis* Rehn belongs to *Gatunia* here described,[26] and *Turpilia paraguayensis* Rehn is a synonym of *Ceraia similis* Caudell.

[26] See our discussion of *Turpilia* and *Diplophyllus* on page 86.

We erected *Montezumina* to include three species originally placed in *Turpilia* and one previously undescribed. All are Mexican, but one, *oblongoculata* of Brunner has been reported from Guatemala and Costa Rica by Saussure and Pictet and from Costa Rica by Rehn. The Costa Rican material apparently represents a geographic race and is here described, as a Panamanian female is before us which should probably be there assigned. A new species is also represented in the Panamanian material, belonging to a very distinct phylum.

Montezumina oblongoculata mesembrina new subspecies (Pl. XIX, fi s. 7, 8 and 9.)

This insect agrees with Mexican material of typical *oblongoculata* (see pl. XIX, fig. 10) in all but male genitalic features.

Type: ♂; Monte Redondo, Costa Rica. March. (L. Bruner.) [Hebard Collection, Type No. 1048.]

Differs from *oblongoculata oblongoculata* only in the cerci. These are elongate, cylindrical, gradually tapering distad to the strongly recurved distal portion, the shaft very slightly curved inward; distal portion erect, forming a right-angle (or slightly more) to the shaft, slightly pinched at base laterad, showing a weak but distinct sigmoid curvature, the apical tooth curving inward to its apex and thus forming the top portion of the weak S.[27]

Allotype: ♀; Rio Surubres, near San Mateo, Costa Rica. Elevation 250 meters. January, 1906. (P. Biolley.) [Acad. Nat. Sci. Phila.]

Indistinguishable from this sex of typical *oblongoculata*. Size very slightly larger than male. Ovipositor rather suddenly curved dorsad beyond the enlarged proximal portion, rather short and deep, lateral margins convex-convergent distad to the acute apex, these margins armed distad with comparatively heavy, rounded teeth; lateral surfaces weakly supplied with granules and ventral valves with a series of more distinct, short, vertical rugae toward their juncture with the dorsal valves. Subgenital plate small, simple, trigonal but rounded at apex,[28]

[27] In Mexican males of typical *oblongoculata* the shaft of the cercus tapers slightly more evenly, the distal portion erect, forming a right-angle to the shaft, not pinched at base, straight, the apical tooth with caudal margin convex to the straight cephalic margin, at the base of which is a minute rectangulate projection, as the base of the apical tooth is narrower than the apex of the cercus.

[28] Sometimes with emargination suggested.

ventral surface flat (in dried specimens often shrunken and forming a deep medio-longitudinal sulcation).

General coloration absinthe green. Eyes light brown. Toothed marginal portions of ovipositor hazel.

The type and allotype measure as follows: length of body ♂ 14.2, ♀ 18.2; length of pronotum ♂ 4, ♀ 4.1; caudal width of pronotal disk ♂ 2.6, ♀ 2.8; length of tegmen ♂ 25, ♀ 26.2; median width of tegmen ♂ 5.6, ♀ 5.8; length of caudal femur ♂ 16.5, ♀ 17.8; length of ovipositor 5.2 mm.

Specimens Examined: 9; 4 males and 5 females.

Esparta, Costa Rica, 50 meters, February, 1905, (P. Biolley), 1 ♀,[29] *paratype*, [A.N.S.P.].

Monte Redondo, Costa Rica, March, (L. Bruner), 1 ♂, *type*, [Hebard Cln.].

Rio Surubres, near San Mateo, Costa Rica, 250 meters, January, 1906, (P. Biolley), 1 ♂, 1 ♀, *paratype* and *allotype*, [A.N.S.P.].

La Emilia, near Guapiles, Costa Rica 1000 feet, August 22, 1923, (J. A. G. Rehn), 1 ♀, [A.N.S.P.].

France Field, Cristobal, Canal Zone, Panama, July 7, 1920, (M. Hebard; perched on leaves of forest undergrowth at night), 1 ♀, [Hebard Cln.].

Central America, (Rev. T. Heyde), 2 ♂, 1 ♀, [Hebard Cln.].

Without males the Panamanian assignment can not be made definitely. That female agrees in every respect with those from Costa Rica.

This is the southernmost record for this interesting genus, readily distinguished by its small size, elongate eyes and ovipositor with roughened lateral surfaces.

Montezumina bradleyi[30] new species (Pl. XIX, fig. 11.)

The present female is nearest *M. oridiops* (Saussure and Pictet), known only from the male. Comparison of the sexes would, therefore, probably show additional important diagnostic characters. It differs from the description of *oridiops* as follows. Face with broad but decided infra-ocular sulci, the margins of which round so gradually that no carinae are developed. Pronotum with disk widening evenly and weakly caudad, rounding into the lateral lobes to the same degree throughout, more rounded than in *M. oblongoculata* (Brunner). Lateral

[29] Recorded by Rehn as *Turpilia oblongoculata*, Proc. Acad. Nat. Sci. Phila., 1905, p. 812, (1905).

[30] Named in honor of our friend, Dr. J. C. Bradley of Cornell University, who has collected a wealth of interesting tropical American Orthoptera in recent years.

lobes of pronotum distinctly deeper than long. Tegmina with mediastine vein weakly indicated as in *oblongoculata*, median vein springing before median point on discoidal vein and forking about its middle; marginal field tessellate distad, as is the distal marginal field of the wings distad. Tegmina and limbs with a few dark markings, these numerous on cephalic tibiae and apices of cephalic femora.

Though clearly a member of *Montezumina*, this species, like *oridiops*, shows divergence toward *Topana* in the limb armament, *bradleyi* exhibiting further this tendency in the marginal markings of the organs of flight.

Type: ♀; Barro Colorado Island, Gatun Lake, Canal Zone, Panama. March 26 to 31, 1924. (J. C. Bradley.) [Hebard Collection, Type No. 1079.]

In addition to the characters given above, the following are noteworthy. Size slightly smaller, form slightly more robust, with shorter limbs and organs of flight than in *oblongoculata*. Fastigium narrow, sulcate to the slightly thickened, truncate apex, the flat cephalic face of which is higher than wide and separated by a narrow space from the facial fastigium. Vertical eyes elongate oval, slightly broader than in *oblongoculata*. Humeral sinus of pronotal lateral lobes forming a deep acute-angulate emargination, as is characteristic of the genus. Tegmina well surpassing apices of caudal femora and surpassed a like distance by the wings. Tegminal transverse veinlets more distinct and regular than in *oblongoculata*. Ovipositor much as here described for *oblongoculata mesembrina*, except that the lateral surfaces are slightly more granulose, with the rugae ventrad less distinct. Subgenital plate as there described but narrower and appreciately emarginate at the apex, the lateral portions of which are rounded. Genicular lobes of cephalic femora roundly produced and armed with (0 to 2) vestigial spines, of median femora with two minute spines and of caudal femora with two heavy spines. Ventral femoral margins armed as follows: cephalic internal gradually becoming strongly lamellate distad, with five spines, the distal of which are rather large; cephalic external and median internal unarmed; median external weakly lamellate with six minute spines; caudal internal with six and caudal external with seven spines.

General coloration light cress green, a darker shade than in *oblongoculata*. Eyes and ovipositor blackish chestnut brown, (the latter possibly partially discolored). Antennae uniform light yellowish brown. Pronotal disk with a minute fleck of

blackish brown on each side at cephalic and caudal extremities. Apices of cephalic femora and cephalic tibiae marked and flecked with blackish brown and elsewhere light brownish bluff. Median and caudal limbs light cress green, the median femora with a heavy fleck of blackish brown on the external genicular lobes, the caudal femora with spines and adjacent suffusions and a few vague distal flecks of the same. Tegmina light cress green, a desiccated fleck of blackish brown proximad in discoidal field and very faint flecks toward the sutural and distal margins; narrow marginal field tessellate distad with dark brown, as is the exposed portion of the marginal field of the wings.

Length of body 13.8, length of pronotum 3.8, caudal width of pronotal disk 2.8, length of tegmen 24.1, median width of tegmen 5.6, length of caudal femur 17.5, length of ovipositor 4.9 mm.

Anaulacomera crassidentata new species (Pl. XIX, figs. 12 and 13.)

This species is nearest *A. gracilis* Brunner, now known from Colombia and Venezuela, differing in the smaller size, broader apex of the fastigium, male cerci which are more incurved throughout and heavier teeth of the female ovipositor.

In size the present insect agrees with the Colombian *A. asema* Hebard,[31] that insect differing in the very slightly wider fastigium, shorter limbs, straighter male cerci with apices more swollen though very feebly so and male subgenital plate flattened concave distad between the strongly produced lateral styliform appendages.

These species we refer to the Gracilis Group, in which the fastigium is broad and sulcate dorsad, the male ultimate tergite simple, and not produced, the male cerci simple, elongate, very weakly to moderately curved with no appendages, the ovipositor with unusually heavy teeth (in the species in which this sex is known), the limbs comparatively short and these and the body flecked with minute pink dots.

Brunner's *A. angusta* is apparently intermediate between these and the many species allied to *A. laticauda* Brunner, which have simple male cerci, a broad but narrower fastigium, more delicate structure, narrower tegmina and more slender limbs.

[31] This and a number of other species of the genus have been recently described, Trans. Amer. Ent. Soc., LII, pp. 295 to 305, (1926).

Type: ♂; Panama City, Panama. November 13, 1913. (M. Hebard.) [Hebard Collection, Type No. 1050.]

Size small, structure slightly less delicate than is usual in the genus. Fastigium sulcate above, its cephalic face rather broad, almost as broad as the first antennal joint, separated from the facial fastigium by a mere line. Pronotal lateral lobes with length equal to depth. Tegmina with branching of median vein variable.[32] Ultimate tergite truncate, showing a meso-distal depressed area, the free caudal margin on each side of this being weakly convex. Supra-anal plate triangularly shield-shaped, deflexed, slightly longer than broad. Cerci simple, elongate, curving moderately inward, slender, showing a mere suggestion of distal thickening; the apex armed with an exceedingly minute tooth, directed inward. Subgenital plate with lateral margins weakly convex and very weakly convergent to the broad apex, the disto-lateral angles surmounted by small nodiform non-articulate appendages which are no longer than wide, the distal margin between these truncate, almost straight or feebly convex laterad and forming a very shallow angulate emargination mesad. Limbs short for the genus. Ventral femoral margins unarmed, except the external of the caudal femora, which (usually) bear one or two (rarely three) microscopic teeth (and sometimes are unarmed). Cephalic tibiae with dorsal surface showing a trace of sulcation.

Allotype: ♀; Ancon, Canal Zone, Panama. February 11, 1920. (J. Zetek.) [Hebard Collection.]

Very similar to male in size, form and ambisexual characters. Ovipositor moderately elongate and narrow for genus, weakly curved dorsad, of almost equal width throughout, with apex acute, margins armed distad with heavy, triangular teeth which are unusually heavy for the genus, lateral surfaces there rather coarsely nodulose. Subgenital plate as in *gracilis;* small, simple, triangular, gripping the base of the ovipositor firmly and showing a mere trace of apical emargination.

General coloration veronese (light) green. Tegmina immaculate except stridulating vein and its immediate vicinity in stridulating area of male tegmen which is tinged with pinkish brown and the minute areas between the veinlets along the sutural margin which are brown. Minute pink flecks are found on occiput and pronotum and also on the limbs of specimens which have not become discolored.

[32] Often branching well beyond median point, sometimes at or before that point; in the type unbranched on one tegmen.

Measurements (in millimeters)

♂	Length of body	Length of pronotum	Length of tegmen	Width of tegmen	Length of caudal femur	Length of ovipositor
Gold Hill. *Paratype*	13.8	3.8	22	4.6	17.3	
Paraiso. *Paratype*..	16.2[33]	3.8	22.7	4.8	18.1	
Ancon. *Paratype* ..	14.7	3.9	22.2	4.9	18.3	
Panama City. *Type*	15.7	3.8	22.3	4.8	18.1	
♀						
Ancon. *Allotype*...	15.7	3.8	——	4.8	17.6	8.2
Panama City. *Paratype*	13[34]	3.8	22.3	4.8	19.2	8.2

Specimens Examined: 24; 11 males, 9 females and 1 immature individual.

Barro Colorado Island, Canal Zone, June 21, 1924, (N. Banks), 1 ♀, *paratype.*

Frijoles, C. Z., July 10, 1924, (N. Banks), 1 ♂, *paratype.*

Red Tank, C. Z., July 1, 1924, (N. Banks), 2 ♀, *paratypes.*

Bella Vista, C. Z., July 6 and August 8, 1924, (N. Banks), 1 ♂, 4 ♀, *paratypes.*

Zone limit five miles west of Empire, Canal Zone, November 14, 1913, (M. Hebard; in vine tangle on ground in open spot in forest), 1 ♂, *paratype.*

Gold Hill, C. Z., November 14, 1913, (M. Hebard; from low bushes overgrown with vines near low forest), 1 ♂, *paratype.*

Paraiso, C. Z., February 6, 1911, (E. A. Schwarz), 1 ♂, *paratype.*

Ancon, C. Z., February 11, 1920, (J. Zetek), 1 ♀, *allotype;* August 8, 1924, (N. Banks), 1 ♂, 1 ♀, *paratypes;* November 12, 1913, (M. Hebard; in short grass and low vines), 1 ♂, *paratype*, 1 large juv.

Panama City, November 13, 1913, (M. Hebard; beaten from bushes on open hillside pasture), 2 ♂, 1 ♀, *type* and *paratypes.*

Anaulacomera laticauda Brunner

1878. *Anaulacomera laticauda* Brunner, Monogr. der Phaneropt., p. 292. [♂, ♀; Orizaba, Mexico.[35]]

1901. *Symmetropleura teocelae* Rehn, Trans. Amer. Ent. Soc., XXVII, p. 222. [♂ (not a ♀); Teocelo, Vera Cruz, Mexico.]

[33] Abdomen distended.

[34] Abdomen shrivelled.

[35] We here select Orizaba, Mexico, as type locality for *laticauda.* Brunner included Colombian material also in his original series, which probably belongs to a distinct but closely allied species.

Incorrect generic association led to the evident synonym *teocelae*, the type being before us. There is in the author's collection a male from San Lorenzo, Cordova, Mexico, correctly recorded by Saussure and Pictet in 1897. Those authors also recorded *laticauda* from Bugaba and David, Panama, but probably included other material of the Laticauda Group among their records.

Gatun, Canal Zone, July 19 to 22, 1916, (D. E. Harrower), 1 ♀.

Barro Colorado Island, C. Z., July 17, 1924, (N. Banks), 1 ♀.

Las Sabanas, July 7, 1924, (N. Banks), 1 ♂.

Taboga, C. Z., June 28, 1924, (N. Banks), 1 ♀.

In considerable series of the genus before us from Nicaragua, Costa Rica and Colombia, allied species but no material of *laticauda* are represented. The present male agrees fully with those from Mexico but, like the Las Sabanas female, has the fastigial apex larger and broader, only slightly narrower than the proximal antennal joint and the tegmina shorter and broader. Additional material may prove specific differentiation but the markings, genitalia and other features agree so exactly that we believe it best to consider them *laticauda*. They might seem referable to *A. lativertex* Brunner (of which species material from Yucatan is in the author's collection), but the pronotal lateral lobes have their length and depth equal. The measurements of these specimens are: length of body ♂ 16, ♀ 21 (abdomen distended); length of pronotum ♂ 4.1, ♀ 4.6; length of tegmen ♂ 26.8, ♀ 26.2; width of tegmen ♂ 5.5, ♀ 6.2; length of caudal femur ♂ 17.5, ♀ 19; length of ovipositor 8.7 mm.

The other two females agree fully with *laticauda*, measuring as follows; length of body 19.7 and 19.7, length of pronotum 4.7 and 4.2; length of tegmen 28.2 and 27.2; width of tegmen 5.8 and 5.3; length of caudal femur 18.2 and 18.5; length of ovipositor 8.7 and 8.2 mm. In these the fastigial apex is slightly over half as wide as the proximal antennal joint. The ovipositor is weakly curved dorsad to its acute apex, with lateral surfaces smooth and margins armed distad with minute, recumbent, weak serrations. The subgenital plate is very small, triangular, with immediate apex truncate.

Anaulacomera spatulata new species (Pl. XIX, figs. 14, 15 and 16.)

This insect belongs to the Laticauda Group, which we discuss briefly with the allied Gracilis Group on page — . The male cerci of *spatulata* are distinctive; the small apices spatulate, the lateral portions there impressed, surmounted by more than one minute chitinous projection. Further difference from that sex of *A. laticauda* Brunner is shown by the subgenital plate, the latero-caudal angles of which are produced in decided, non-articulate, styliform projections.

Type: ♂; Porto Bello, Panama. February 15, 1911. (E. A. Schwarz.) [United States National Museum.]

Size medium for the genus, form graceful, structure very delicate. Fastigium sulcate dorsad, its cephalic face small, about three-fifths as wide as the first antennal joint. Pronotal lateral lobes distinctly, though not decidedly, longer than deep,[36] the caudal margin distinctly flattened. Tegmina with median vein branching beyond median point. Ultimate tergite truncate, the distal margin very broadly and evenly convex. Supra-anal plate short, rounded trigonal. Cerci simple, very elongate, slender, curving inward strongly, spatulate at apex, the lateral surfaces of this portion feebly concave, its generally rounded margin produced ventro-distad in a minute, microscopically denticulate, chitinous ridge, above which, at the median apical point is a minute, erect, chitinous tooth. Subgenital plate with lateral margins convergent to two prominent, elongate conical, non-articulate, straight, styliform projections, each twice as long as its proximal width, the intervening caudal margin concave between these. Limbs elongate and slender. Ventral femoral margins unarmed except cephalic of cephalic femora and both of caudal femora, which bear a few minute teeth. Cephalic tibiae with dorsal surface subsulcate distad.

Allotype: ♀; Fort Sherman, Canal Zone, Panama. July 3, 1924. (N. Banks.) [Museum of Comparative Zoology.]

Agrees with male except as follows. Size larger, form more robust. Genitalia much as in *laticauda*, but ovipositor more elongate, evenly and broadly curved dorsad, with lateral surfaces smooth, the dorsal margin very finely serrulate, the ventral margin more coarsely serrulate distad. Subgenital plate triangular, with apex truncate.

[36] For *laticauda* described as of equal length and depth, but in our specimens of that species best termed very slightly longer than deep.

General coloration light green, the pronotum showing a very few minute pink dots. Tegmina with small areas between the veinlets along the sutural margin brown and more conspicuous than in the species of the Gracilis Group; brown in vicinity of stridulating vein in male; a very few areolae proximo-laterad and also distad in anal area brown in female. Wings with veins pink in type and allotype, hyaline in the other specimens.

Measurements (in millimeters)

	Length of body	Length of pronotum	Length of tegmen	Width of tegmen	Length of caudal femur	Length of ovipositor
♂						
Bella Vista. *Paratype*	18	4.7	28.8	5.4	18	——
Porto Bello. *Type*	15.7	4	25.8	5.4	16.9	——
Porto Bello. *Paratype*	19.7[37]	4.7	27.8	5.7	16.8	——
♀						
Fort Sherman. *Allotype*	16.7	4.7	30.8	5.6	20	9.2
Barro Colorado Island. *Paratype*	20	5	31.2	5.9	19.8	9.3

Specimens Examined: 5; 3 males and 2 females.

Barro Colorado Island, Canal Zone, 1924, (N. Banks), 1 ♀, *paratype.*

Fort Sherman, C. Z., July 3, 1924, (N. Banks), 1 ♀, *allotype.*

Porto Bello, February 15 and March 10, 1911, (Schwarz and Busck), 2 ♂, *type* and *paratype.*

Bella Vista, August 8, 1924, (N. Banks), 1 ♂, *paratype.*

We also have before us a male from Las Quiguas, Venezuela, taken in September, 1910, by M. A. Carriker, Jr., belonging to the Academy. This specimen agrees very closely with the Panamanian males but has the apices of the cerci slightly narrower, the spatulation less marked in consequence, but the concavity of the lateral surfaces and armament identical. It measures; length of body 19.5 (abdomen distended), length of pronotum 4.2, length of tegmen 27.2, width of tegmen 5.6, length of caudal femur 17.4 mm.

Anaulacomera uncinata new species (Pl. XX, figs. 1 and 2.)

Of the described species, *uncinata* shows nearest relationship to *A. alfaroi* Rehn, agreeing very closely in all features except the more heavily suffused stridulating field of the male tegmina and the very distinctive quadricarinate male cerci.

[37] Abdomen distended.

The very small fastigial apex, form of pronotal lateral lobes and stridulating field of male tegmina, tegminal venation and male subgenital plate, readily serve to separate these species from the other known Central American forms, the nearest affinity being apparently with the very distinct Colombian *A. dentata* Brunner.

Type: ♂; Barro Colorado Island, Gatun Lake, Canal Zone, Panama. April 7, 1924. (J. C. Bradley.) [Hebard Collection, Type No. 1080.]

Size below medium for the genus, form graceful, structure delicate. Fastigium sulcate dorsad, its cephalic face very small, about one-third as wide as proximal antennal joint. Pronotal lateral lobes distinctly longer than deep, the caudal margin oblique and nearly straight. Tegmina with median vein branching beyond median point (more distal in some of the specimens than in others). Ultimate tergite truncate; its distal margin transverse, straight. Supra-anal plate triangular with apex bluntly rounded, slightly longer than proximal width, its dorsal surface sloping strongly down to a medio-longitudinal line. Cerci small, their stout cylindrical bases springing from projecting sockets, thence produced as a slender claw, directed horizontally inward and slightly curved inward, this portion supplied with four sharp, decided, longitudinal carinae to the aciculate apex, between which the surface is concave, the ventral pair of these carinae much more widely separated from each other than is the dorsal pair. Subgenital plate short, briefly produced distad with lateral margins there parallel and apex transversely truncate, feebly bilobate between the weakly produced and rounded latero-caudal angles, the distal (produced) portion wider than long. Limbs moderately elongate and slender. Ventral femoral margins armed with minute teeth, except the caudal of the cephalic and median which are unarmed. Cephalic tibiae with dorsal surface sub-deplanate, showing no trace of sulcation.

Allotype: ♀; same locality as type. July 21, 1924. (N. Banks.) [Museum of Comparative Zoology.]

Agrees with male except as follows. Size larger, form more robust. Ovipositor elongate and curving gradually and weakly dorsad to the acute apex; the dorsal margin very finely serrulate distad, the ventral margin more strongly so; lateral surfaces smooth. Subgenital plate very short, lateral margins rounding and becoming transverse, there produced as two rounded triangular projections which embrace the ovipositor,

their short external margins nearly parallel, their internal margins convex meso-proximad, forming a broadly obtuse-angulate median emargination of the plate, which has its apex rounded and deep.

General coloration light green, pronotum and femora so finely and widely dotted with pink that this can not be detected with the naked eye. Tegmina of male with all but narrow margins of stridulating field vandyke brown, this marking consequently heavier and more extensive than in *alfaroi* and weaker and less extensive than in *dentata*. Minute areas between veinlets along sutural margin of tegmina dark brown in all but the palest examples.

A series of five paratypic males, taken at the same locality as the type, from March 26 to July 21, 1924, agree closely with it in size. Length of body ♂ 14.2, ♀ 18.2; length of pronotum ♂ 4.7, ♀ 4.6; length of tegmen ♂ 23.4, ♀ 27.3; width of tegmen ♂ 4.8, ♀ 5.7; length of caudal femur ♂ 16.3, ♀ 16.2; length of ovipositor 10 mm.

Anaulacomera alfaroi Rehn

1918. *Anaulacomera alfaroi* Rehn, Trans. Amer. Ent. Soc., XLIV, p. 351, pl. 18, figs. 24 to 26. [♂; Orotina, Costa Rica.]

Bocas del Toro, July 1 to 10, 1908, (Wirt Robinson), 1 ♀.
Tabernilla, Canal Zone, May 4, 1907, (A. Busck), 1 ♂.
Barro Colorado Island, C. Z., April 7, 1924, (J. C. Bradley), 1 ♂; July 20, 1924, (N. Banks), 1 ♀.

We also have a female before us in the author's collection, taken in Costa Rica, by C. F. Underwood, and three females belonging to the Academy, taken at Eden, Nicaragua, April 18 to May 21, 1922, by Wharton Huber. The close agreement in ambisexual characters leads us to believe the present sex association to be correct.

The previously unknown female shows the following features of importance. Ovipositor evenly and broadly curved dorsad with margins very feebly serrate; width slightly greatest meso-distad; lateral surfaces smooth. Subgenital plate broad, its latero-caudal angles briefly acute-angulate produced with apices sharply rounded.[38] between which the caudal margin is broadly concave.

[38] The Bocas del Toro female has the subgenital plate somewhat malformed latero-caudad, with projections indicated as a low convexity on one side and obsolete on the other. It otherwise agrees so closely and distortion is so evident there, that we believe we are safe in referring it to *alfaroi*.

In both sexes the apex of the fastigium is small, about half the width of the first antennal joint at its base.

The position of this species is apparently between the Laticauda and Furcata Groups.

Measurements (in millimeters)

	Length of body	Length of pronotum	Length of tegmen	Width of tegmen	Length of caudal femur	Length of ovipositor
♂						
Tabernilla, Panama	13.8	3.9	23	4.4	14.2	——
♀						
Bocas del Toro, Panama.....	17	4.3	25.7	5.7	15.3	8.5
Costa Rica	17.5	4.2	27.2	5.7	16.2	9.9
Eden, Nicaragua...	15.8	4.1	25.7	5.7	14.4	8.7
Eden, Nicaragua...	16.8	4.1	26	5.2	15.2	9.1

It becomes constantly more evident that size differences, such as are found above, may be expected in many species of the genus *Anaulacomera*.

Anaulacomera furcata Brunner

1878. *A[naulacomera] furcata* Brunner, Monogr. der Phaneropt., p. 287. [♀, Panama.]

1896. *A[naulacomera] darwini darienica* Griffini, Boll. Mus. Zool. Anat. Comp. Univ. Torino, XI, No. 232, p. 5. [♂, Punta di Sabana,[39] and ♀, Rio Cianati, Darien.]

It is with considerable regret that we find we are obliged to place Griffini's amply described *darienica* as a synonym of *furcata*, based by Brunner on a badly damaged female. Study, however of the Panamanian series and Costa Rican material including other species of this group, gives convincing proof of this synonymy.

This insect is very distinct from *A. darwini* Scudder of the Galapagos Islands, not a race of that species as Griffini supposed.

[39] We here select this male as type of *darienica*. The female is insufficiently described to locate but its measurements show that it was probably incorrectly associated, representing a larger species with longer tegmina and ovipositor. Griffini's measurements for the male and Brunner's for the female agree closely with those of the present series, in which we are convinced that the proper sex association has been made.

France Field, Canal Zone, July 7, 1920, (M. Hebard; at night, out on leaves of vine-covered bushes), 1 large juv. ♀; August 18, 1920, (M. Hebard; few in leafy tangles of vine-covered bushes), 1 ♂, 3 ♀.

Gatun, C. Z., July 28 to August 5, 1916, (D. E. Harrower), 1 teneral ♂.

Barro Colorado Island, July 31, 1924, (N. Banks), 1 ♂, 1 ♀.

Rio Trinidad, March 19, 1912, (A. Busck), 1 ♂.

Ancon, C. Z., August 6, 1924, (N. Banks), 1 ♀.

The fastigium is not sulcate dorsad, but the vertex proximad above the lateral ocelli is more raised and there weakly sulcate as a result.

The pronotal lateral lobes vary from slightly longer than deep, to having these dimensions subequal.

As in other groups, the median vein of the tegmina varies individually in *furcata*. It usually forks well before the median point (as described by Griffini), but Brunner's specimen had this vein forking far beyond that point, the forking of one of the branches showing further that the type of *furcata* is abnormal in this respect.

Differences in such features apparently led Griffini away from consideration of *furcata*, that author being plainly unfamiliar with the relative values of the characters in the species of this genus. Such is shown by his unusually long description of *darienica* failing to mention the female subgenitial plate.

In this species the females agree closely with the males or slightly exceed them in size and length of tegmina. The median angulation of the dorsal margin of the ovipositor is conspicuous.

In the males the stridulating field is blackish brown mesad, leaving its margins broadly green.

Viadana zetterstedti (Stål)

1860. *Phylloptera zetterstedti* Stål, Kongl. Svenska Freg. Eugenie's Resa, Zool., I, p. 322. [♂; Puna, Ecuador.]

Barro Colorado Island, Canal Zone, July 13, 1924, (N. Banks), 1 ♂.

Rio Trinidad, March 9 and 20, 1912, (A. Busck), 3 ♂.

Porto Bello, April 20, 1912, (A. Busck), 1 ♀.

Alhajuela, March 8, 1912, (A. Busck), 1 ♂.

Material before us shows that this insect occurs from Nicaragua to western Ecuador.

Phylloptera dimidiata Brunner

1878. *Ph[ylloptera] dimidiata* Brunner, Monogr. der Phaneropt., p. 314. [♂, Colombia.]

1896. *Ph[ylloptera] finoti* Griffini, Boll. Mus. Zool. Anat. Comp. Univ. Torino, XI, No. 232, p. 3. [♂; Punta di Sabana, Darien.]

1906. *Turpilia grandis* Rehn, Proc. U. S. Nat. Mus., XXX, p. 597, figs. 1 and 2. [♀; San Carlos, Costa Rica.]

This species belongs to that section of the genus which has a strong Amblycoryphoid appearance. In *dimidiata* the metazonal portion of the pronotal disk is velutinous, surrounded by a black line which often is extended narrowly on the tegmina latero-caudad, the enclosed area deep olivaceous or blackish, rarely yellowish in part. Griffini was apparently misled by individual variation, while Rehn's generic assignment led to his synonym.

Gatun, Canal Zone, July 25 to 31, 1916, (D. E. Harrower), 1 ♂.

Barro Colorado Island, C. Z., July 29, 1924, (N. Banks), 1 ♀.
Rio Trinidad, March 17, 1912, (A. Busck), 1 ♀.

The species was recorded from Bugaba, Panama, by Saussure and Pictet. We have hitherto unreported material before us from as far north as Eden, Nicaragua, while it has recently been recorded by us from as far south as Fusugasugá, Colombia.

Phylloptera panamae new species (Pl. XX, figs. 3 and 4.)

This species is nearest *P. festae* Griffini, agreeing in having the cephalic tibiae subsulcate dorsad and there armed with a single disto-internal spine; the exactly similar head with fastigium acuminate and widely separated from the facial fastigium; face strongly oblique and laterad angulate-compressed; the tegmina with five oblique bands perpendicular to the branches of the median vein, and very similar male genitalia.

It differs from *festae* in being generally weakly glabrous instead of everywhere opaque, the pronotal disk longer and widening less caudad, the tegmina narrowing more gradually distad due to the much broader convexity of the sutural margin to the broadly rounded apex; the stridulating field of the male tegmina smaller and considerably shorter; the pronotal lateral lobes with depth equal, instead of very slightly greater than, their width and the proportionately somewhat more elongate caudal limbs.

Type: ♂; Rio Trinidad, Panama. March 17, 1912. (A. Busck.) [United States National Museum.]

We note the following characters, in addition to those given above. Size slightly under medium, form moderately slender for the genus. Lateral carinae of pronotal disk sharply rounded, considerably more strongly defined than in *festae*. Tegmina with surface opaque but all veins and veinlets glabrous, giving an evenly weakly glabrous appearance to the naked eye; median vein branching proximad; transverse veins of oblique bands slightly raised with narrow adjacent surfaces proximad slightly darkened, these features causing the bands to be conspicuous, much more so than in *festae*. Apices of wings projecting ventrocaudad well beyond apices of tegmina.[40] Ultimate tergite truncate. Cerci moderately elongate, slenderly cylindrical, tapering, curved feebly dorsad, the apex with inner margin chitinous and tipped with a small blunt tooth. Subgenital plate moderately produced, with a rounded carina forming each lateral margin, these truncate distad and surmounted by small, straight, tapering styles, which are three times as long as their proximal width; intervening caudal margin of plate truncate, showing weak obtuse-angulate production.

General coloration very pale yellowish green and generally weakly glabrous. Lateral carinae of pronotum narrowly purplish. Tegmina with costal margin proximad narrowly reddish brown.

The measurements of the type are followed by those of two paratypic males, taken on Barro Colorado Island, Canal Zone, June 24, and July 27, 1924, by N. Banks. Length of body 22, 20 and 21; length of pronotum 6.7, 6 and 6.9; cephalic width of pronotal disk 2.9, 2.8 and 3; caudal width of pronotal disk 4, 3.9 and 4.4; width of pronotal lateral lobe 4.8, 4.8 and 5; depth of pronotal lateral lobe 4.8, 4.8 and 5; length of tegmen 35.7, 33.8 and 35.7; greatest tegminal width 11.2, 10.4 and 11; length of stridulating field of tegmen (from lateral base to distal indentation) 7, 6.4 to 6.8; length of caudal femur 18, 18.2 and 17.9 mm.

Phylloptera festae Griffini

1896. *Phylloptera festae* Griffini, Boll. Mus. Zool. Anat. Comp. Univ. Torino, XI, No. 232, p. 2. [♂; Punta di Sabana, Darien.]

1924. *C[oelophyllum] lineamentis* Vignon, Bull. Mus. Nat. d'Hist. Nat. France, XXX, p. 304. [♀; Buenos Aires and Rio Saavegre, Costa Rica.]

We are convinced, from Vignon's description, that his *lineamentis* represents the previously undescribed female of *festae*. The genera *Phylloptera* and *Coelophyllum* (= *Itarissa*) are very

[40] In *festae* less extensively projecting, so that they extend hardly at all caudad of the tegminal apices.

poorly defined by Brunner. In fact, as understood by us, the species of *Itarissa* are separable from the glabrous forms of *Phylloptera* only by the broader marginal field of the tegmina proximad, which results in the costal margin curving more suddenly proximad and then straight and perpendicular to the humeral trunk. In *Phylloptera* the apices of the wings project amply or briefly, in *Itarissa* they are often concealed entirely but project briefly in some species.

In *Phylloptera* several very distinct appearing phyla are included and revision should be undertaken as soon as the genotype, *cassinaefolia* (Serville) can be located, properly described and compared with the other species.

Chiriqui, 1 ♂, [Hebard Cln.].

Gatun, Canal Zone, July 25 to August 22, 1916, (D. E. Harrower), 2 ♂.

Barro Colorado Island, C. Z., May 7, 1924, (J. C. Bradley), 1 ♂; July 19, 1924, (N. Banks), 1 ♂.

Rio Trinidad, June 4, 1912, (A. Busck), 2 ♂.

Panama, (H. E. Wetherill), 2 ♂, [A.N.S.P.].

This handsome species belongs to that category in which the tegmina are opaque and the face is strongly compressed laterad.

Itarissa[41] **costaricensis** (Rehn)

1917. *Coelophyllum costaricense* Rehn, Ent. News, XXVIII, p. 156, pl. 12, fig. 3. [♂; Cachi, Costa Rica.]

Bugaba, Chiriqui, (W. Schaus), 1 ♀.

Barro Colorado Island, Canal Zone, July 15, 1924, (N. Banks), 1 ♂.

The female differs from the male sex in the decidedly larger size and much more ample and differently shaped tegmina, the sex association being easily made by noting the very close similarity in the many ambisexual characters.[42]

Not only are the forms of the Laurinifolia Group, to which this species belongs, distinguished by the median vein of the tegmina springing from the humeral vein before the median point and the ulnar vein granulose proximad, but also by the

[41] We have recently placed *Coelophyllum* as a synonym of *Itarissa*, Trans. Amer. Ent. Soc., LII, p. 308, (1927).

[42] The differences between the Peruvian female type of *I. simplex* (Scudder) and the males of *Coelophyllum peruvianum* Rehn are so like those shown between the sexes of *costaricensis*, that the synonymy of *peruvianum* under *simplex* appears probable.

female having the tegminal marginal field gradually expanding distad, the costal margin there rounding and thence straight and oblique to the apex.

The present insect is nearest *I. crenulata* (Brunner), which may prove to be a synonym of *I. laurinifolia* (Walker); in fact it is so close that reduction to geographic racial status may eventually be found necessary.

The female here recorded has the two tegminal spots greatly reduced, as is also true for a topotypic male in the Academy collection.

The Panamanian male agrees closely with Costa Rican males except in being smaller, the measurements of a topotypic male being given last for that sex to show this difference. Length of body ♂ 22.8 and 22.3, ♀ 31.5; length of pronotum ♂ 6.4 and 6.9, ♀ 7.8; caudal width of pronotal disk ♂ 4.5 and 5, ♀ 5.8; depth of pronotal lateral lobe ♂ 5.2 and 5.4, ♀ 6.6; width of pronotal lateral lobe ♂ 4.9 and 5, ♀ 5.9; length of tegmen ♂ 34 and 40.3, ♀ 44.2; greatest tegminal width ♂ (median) 13.5 and 15.1, ♀ (meso-distal) 21.7; meso-proximal width of tegminal marginal field ♂ 6.3 and 6.8, ♀ 8.8; meso-distal width of tegminal marginal field ♂ 4.3 and 4.8, ♀ 9.3; length of caudal femur ♂ 15.1 and 15.6, ♀ 18.3; length of ovipositor 5.8 mm.

Itarissa flavo-limbata (Brunner)

1891. *Prosagoga flavo-limbata* Brunner, Addit. Monogr. der Phaneropt., p. 172. [♂, ♀; upper Amazon.]

Barro Colorado Island, Canal Zone, April 7, 1924, (J. C. Bradley), 2 ♂.

Length of body 19.3 and 27, length of pronotum 6 and 6.3, length of tegmen 30 and 32, greatest tegminal width 11.7 and 13.8, length of caudal femur 14.5 and 15.2 mm.

Material of this insect from Alhajuela and Cachi, Costa Rica, is in the Academy collection.

Pycnopalpa bicordata (Serville)

1825. *L[ocusta] bicordata* Serville, Encycl. Méthod., Ins., x, p. 343. [♀, Brazil.]

1903. *Pycnopalpa mortuifolia* Rehn, Trans. Amer. Ent. Soc., xxix, p. 21. [♂; Teocelo, Vera Cruz, Mexico.]

The above synonymy was indicated by Vignon in 1924.[43] Rehn's type, compared with material from Mexico, Guatemala,

[43] Bull. Mus. Nat. d'Hist. Nat. France, xxx, p. 301.

Nicaragua, Costa Rica, Panama, Colombia and Brazil, shows only very slight differences, clearly referable to individual variation.

La Chorrera, May 9, 1912, (A. Busck), 1 ♂.
Miraflores, Canal Zone, (A. H. Jennings), 1 ♀.

Microcentrum philammon Rehn.

1918. *Microcentrum philammon* Rehn, Trans. Amer. Ent. Soc., XLIV, p. 357, pl. 19, figs. 7 to 9. [♂; Puntarenas, Costa Rica.]

Bocas del Toro, July 1 to 10, 1908, (Wirt Robinson), 1 ♀.
Gatun, Canal Zone, July 25 to August 22, 1916, (D. E. Harrower), 3 ♂, 1 ♀.
Barro Colorado Island, C. Z., April 7, 1924, (J. C. Bradley), 1 ♀; June 23, 1924, (A. Busck), 1 ♂.
Panama City, (J. Zetek), 1 ♀.

This insect is a member of the Lanceolatum Group and Saussure and Pictet's record of that species from San Geronimo, Nicaragua, is probably referable to *philammon*. Nicaraguan material of *philammon* is before us.

Microcentrum sp.

We have before us several Central American species of *Microcentrum* belonging near *M. retinerve* (Burmeister). That species is now known to be confined to the eastern United States. It is therefore certain that Saussure and Pictet's Biologia records of *retinerve* from outside the United States, including one from Chiriqui, Panama, are incorrect, probably referable to a number of more or less closely related species.

A female before us, taken at France Field, Canal Zone, Panama, by the author on July 7, 1920, from forest foliage at night, represents a species related to *retinerve*. It agrees closely in size and general structure, differing in the less sulcate fastigium, cephalic margin of pronotum moderately undulate, tegmina narrowing more strongly distad, longer and heavier caudal limbs and decidedly smaller ovipositor. Until better understood we believe that species of this group should not be described without males.

Microcentrum concisum Brunner

1878. *M[icrocentrum] concisum* Brunner, Monogr. der Phaneropt., p. 340. [♀, Colombia.]

La Chorrera, May 9, 1912, (A. Busck), 1 ♂.
Rio Trinidad, March 22, 1912, (A. Busck), 1 ♂.
Panama, 1 ♂, [Hebard Cln.].

These specimens agree closely with Brunner's description which, however, is decidedly inadequate. All have the dorsal portion of the tympana of the cephalic tibiae and the adjacent area dorsad on the external faces, black; a feature not mentioned by that author.

The venation is exactly as figured for *M. championi* Saussure and Pictet,[44] that insect being decidedly larger and having the fastigium considerably narrower.

[44] Biol. Cent.-Amer., Orth., I, pl. 16, fig. 30, (1898).

The extremes for these males measure; length of body 20.8 to 23, length of pronotum 5.8 to 6, caudal width of pronotal disk 5 to 5.1, length of tegmen 35 to 37.4, greatest tegminal width 12.8 to 13.1, length of caudal femur 16.8 to 16.9 mm.

A decidedly smaller male of this same species, taken at Eden, Nicaragua, May 18, 1922, by Wharton Huber, is in the Academy collection.

Lamprophyllum micans Hebard

1924. *Lamprophyllum micans* Hebard, Proc. Acad. Nat. Sci. Phila., LXXVI, p. 205, pl. 9, fig. 11. [♂, ♀; Eden and Great Falls, Nicaragua; Carrillo, Costa Rica; Rio Trinidad, Panama; Andagoya, Colombia, and Bucay, Ecuador.]

Barro Colorado Island, Canal Zone, March 26 to April 7, 1924, (J. C. Bradley), 6 ♂; June 23, 1924, (N. Banks), 1 ♂.

Rio Trinidad, March 15 to June 10, 1912, (A. Busck), 7 ♂.

It is of interest to note that of the Group Microcentri, only the two species of this genus and *Microcentrum otomium* (Saussure) of the described forms, have the costal margin of the tegmina very narrowly blackish brown.

Two additional similarly marked undescribed species of *Lamprophyllum*, however, are before us in our unstudied Costa Rican series, and the same is true of the following species, here described.

Lamprophyllum bugabae new species (Pl. XX, fig.5.)

The large size, broad fastigium and apert foramina of the cephalic tibiae separate the present female from that sex of *Lamprophyllum micans* Hebard, to which alone it shows close general similarity in all other respects.

The auditory foramina of the cephalic tibiae would apparently indicate generic separation, but from our series of *micans* we find one case where the internal foramina of the cephalic tibiae

are much less nearly closed than is usual. In the present specimen, the internal foramina, though apert, are seen to have the ventral margin slightly produced. Realizing the close agreement with *micans* in all but two other characters, we believe it best to consider these species congeneric.

Such unusual variability in the auditory foramina further indicates that *Ischyra frutetorum* Saussure and Pictet may also belong to this genus.

Type: ♀; Bugaba, Chiriqui, Panama. (W. Schaus.) [United States National Museum].

Size large, form graceful though moderately robust. Head smooth. Fastigium over three times as wide as proximal antennal joint, sulcate and depressed, rounding to facial fastigium and in full contact with it. Eyes protruding as in this sex of *micans*, with length approximately three-fifths that of infraocular portion of genae. Pronotum smooth; disk expanding caudad, showing a coarse but obscure medio-longitudinal carina in cephalic portion, rounding gradually into the lateral lobes, this slightly stronger caudad, cephalic margin feebly bi-undulate, caudal margin convex; first sulcus distinct briefly laterad on disk and dorsad on lateral lobes, principal sulcus best indicated by an impression on each side of the median carina; lateral lobes almost perpendicular, decidedly higher than wide. Tegmina and wings fully developed, the former coriaceous and strongly glabrous; first branch of median vein longitudinal, running to apex of tegmina. Mesosternal and metasternal lobes sharply triangularly lobate. Ovipositor small, suddenly recurved proximad, serrate only along distal portion of dorsal margin. Subgenital plate triangularly produced, longer than broad, apex rounded, surface decidedly sulcate medio-longitudinally proximad. Cephalic and median femora with ventro-cephalic margins spined, as are both ventral margins of caudal femora; genicular lobes of cephalic and median femora bluntly triangular and armed with a small ventral spine, of caudal femora bispinose. Auditory foramina of cephalic tibiae as described above. Caudal tibiae with dorsal and lateral surfaces broadened and weakly concave, this stronger proximad on the lateral surfaces, the lamellate margins supplied with numerous very small spines.

General coloration shining, light green. Tegmina with proximal portion of costal margin showing a very narrow line of blackish brown, this bordered internally by a wider suffusion of buffy, which is continued as a narrow marginal line to near apex. Spines of limbs very inconspicuously tipped with brown.

Length of body 34.5, width between antennal sockets 2.2, length of pronotum 8.3, caudal width of pronotal disk 6.3, length of tegmen 55.8, greatest tegminal width 17.4, length of caudal femur 28.9, length of ovipositor 6.2 mm.

Philophyllia guttalata Stål

1873. *P[hilophyllia] guttulata* Stål, Öfv. K. Vetensk.-Akad. Förh., 1873, No. 4, p. 42. [♀, Brazil.[45]]

Porto Bello, March, 1911, (A. Busck), 1 ♂.
Ancon, Canal Zone, 1 ♂, [Hebard Cln.].

We have recently recorded a specimen of this katydid from Orocué, Colombia. The species is, however, much more abundant and widely distributed through Central America into tropical Mexico.

Pseudophyllinae

ACANTHODIPHRUS Walker

Kirby has correctly placed *Cecentromenus* Brunner as a synonym of *Acanthodiphrus* Walker, as in these monotypic genera *C. marmoratus* Brunner proves to be a synonym of *A. conspersus* Walker.

We now find that the monotypic *Tetanophrys* Brunner is also a synonym of *Acanthodiphrus*, for the same reason; *T. nitidus* Brunner being a synonym of *A. conspersus* Walker.

Acanthodiphrus conspersus Walker

1871. *Acanthodiphrus conspersus* Walker, Cat. Dermapt. Saltat. British Mus., v, p. 48. [♀; Chontales, Nicaragua.]

1895. *Tetanophrys nitidus* Brunner, Monogr. der Pseudophyll., p. 106, pl. 5, fig. 48. [♀; Chiriqui, Panama (not Ecuador).]

Comparison of the original descriptions with material before us, of which a female from Carrillo, Costa Rica, has been recorded as *Cecentromenus marmoratus* by Rehn, gives convincing evidence of this synonymy. Brunner apparently ran material of this species to two different sections of his key, through different conclusions as to the metasternal foveolae.

We believe that only a single species of *Acanthodiphrus* is yet known, the three South American species referred here by Kirby in 1906 being much closer to *Cocconotus* Stål or actually members of that genus as indicated by Giglio-Tos in 1898.

Bocas del Toro, 1912, (J. Zetek), 1 ♂.

[45] Corrected; Mexico, in 1874.

Unfortunately the genitalia of this, the first known male, are damaged. It measures; length of body 43, length of pronotum 10.7, length of tegmen 61.8, greatest tegminal width 11.4, length of cephalic femur 24, length of caudal femur 45 mm.

Championica montana Saussure and Pictet

1898. *Championica montana* Saussure and Pictet, Biol. Cent.-Amer., Orth., I, p. 405, pl. 20, fig. 1. [♂; Chiriqui Volcano, Panama.]

Central America,[46] (Rev. T. Heyde), 1 ♂.

This specimen shows clearly the close affinity to *Acanthodiphrus* Walker in fastigium, texture color and venation of tegmina, color of wings and armament of limbs, though having a much more striking pronotal armament. The spines there found closely resemble those developed in *Orpacophora coronata* (Linnaeus) but more careful examination shows a different arrangement, again nearer *Acanthodiphrus*.

Lichenochrus rehni new name

1906. *Lichenochrus marmoratus* Rehn, Proc. Acad. Nat. Sci. Phila., 1905, p. 314, figs. 10 and 11. [♀; Carrillo, Costa Rica.]

We propose this name for *L. marmoratus* Rehn, preoccupied by the African *L. marmoratus* Sjostedt, 1902.

Rio Trinidad, March 30, 1912, (A. Busck), 1 ♂.

This individual agrees closely with a male from Pozo Azul de Pirris, Costa Rica, in the author's collection. It measures; length of body 23, length of pronotum 5.8, caudal width of pronotal disk 4.2, length of tegmen 29, width of tegmen 8.3, length of caudal femur 24 mm.

We do not believe that *L. muticus* Brunner, described from Chiriqui, Panama, is congeneric.

Pristes tuberosus (Stål)

1875. *P[latyphyllum] tuberosum* Stål, Bih. till K. Svenska Vet.-Akad. Handl., III, No. 14, p. 40. [♀; Chiriqui [,Panama].]

Gatun, Canal Zone, July 19 to 22, 1916, (D. E. Harrower), 1 ♂.
Barro Colorado Island, C. Z., July 15, 1924, (N. Banks), 1 ♀.
Tabernilla, C. Z., (A. Busck), 1 ♂.

Northward this large species is known as far as Nicaragua. It has been recorded from Chiriqui and the Rio Cianati and Lake Pita, Darien, Panama.

[46] Very possibly from Panama. The material collected by Heyde was too carelessly labelled to warrant giving a more definite locality than this.

BALBOA new genus

1895. *Gongrocnemis* Brunner, in part, Monogr. der Pseudophyll., p. 164.[47]

This genus is erected to include a single species,[48] described as *Gongrocnemis tibialis* Brunner. It differs from *pallidespinosa* Brunner,[49] genotype of *Gongrocnemis*, in the more robust build, broader fastigium, pronotal metanotum more strikingly deplanate, male ultimate tergite truncate and not greatly produced, cephalic tibiae decidedly enlarged proximad, this terminating suddenly and all tibiae with sides flattened and slightly impressed between the sublamellate margins.

The form is decidedly less cylindrical than in most of the species of *Gongrocnemis*.

Balboa tibialis (Brunner) (Pl. XX, fig. 6.)

1895. *Gongrocnemis tibialis* Brunner, Monogr. der Pseudophyll., p .165. [♀; Panama; Medellin, Colombia.]

We here record all of the material of this handsome species before us.

Eden, Fis Fis District, Nicaragua, summer of 1922, (T. W. Bouchelle), 1 ♂, [A.N.S.P.].

La Emilia, near Guapiles, Costa Rica, August 24, 1923, (J. A. G. Rehn), 1 ♂, [A.N.S.P.].

Caché, Costa Rica, June, 1916, (C. H. Lankester), 1 ♂, [A.N.S.P.].

Tabernilla, Canal Zone, Panama, May 7, 1907, (A. Busck), 1 ♂, 1 ♀.

Barro Colorado Island, Canal Zone, Panama, April, 1924, (A. Busck), 1 juv. ♂.

One of the most distinctive features of coloration is shown by the snuff brown tegmina, which meso-proximad in the discoidal field have what appears to be a broad smear of shining blackish brown, this continued caudad to varying degrees, there fading out and often showing one or two small buffy flecks.

[47] Section 1 of Brunner's key.

[48] From the literature it appeared possible that *Gongrocnemis dentipes* Saussure and Pictet might be near or referable to *Balboa*. A female of that species from Nicaragua before us shows that it is, however, widely distinct. It has a strong Lichenochroid appearance, but in that section of Brunner's key runs nearer genera of very different aspect.

[49] A recorded series from Venvidio, Sinaloa, Mexico, is in the author's collection.

The previously unknown male agrees closely with the female in general appearance. Stridulating area of tegmen shining blackish brown, broadly margined with snuff brown. Ultimate tergite feebly produced, with distal margin between cerci broadly concave. Supra-anal plate almost vertical, with rounded apex less so. Cerci heavy, cylindrical, almost straight, tapering to the slightly incurved apex, which is surmounted by a heavy, weakly curved tooth, directed at right angles to the shaft. Subgenital plate rounded V-emarginate distad, the lateral apices surmounted by elongate, straight styles.

The measurements of the Costa Rican, Nicaraguan and Panamanian males are given in this order. Length of body ♂ 38.7, 39 and 39.5, ♀ 53.5; length of pronotum ♂ 11, 12.2 and 12.3, ♀ 12; caudal width of pronotal disk ♂ 6.9, 7.2 and 7.3, ♀ 7.7; length of tegmen ♂ 41, 43 and 44.7, ♀ 46; greatest tegminal width ♂ 10.5, 11.2 and 11.7, ♀ 12.1; length of caudal femur ♂ 27.8, 29 and 31, ♀ 31.3; length of ovipositor 23.5 mm.

The color of the immature individual is much more diversified than that of the adults. It is strongly mottled, the pronotal disk and annuli of the tibiae and caudal femora very pale grayish.

Idiarthron major new species (Pl. XX, fig. 7.)

This handsome insect is larger than the previously known forms of the genus, in appearance somewhat suggesting species of the South American genus *Meroncidius*.

It is nearest *I. atrispinum* (Stål),[50] differing in the very large size, moderately conchate instead of subconchate auditory foramina of the cephalic tibiae and distinctive male genitalia.

The two lateral horns of the male ultimate tergite apparently constitute a valuable generic character in *Idiarthron*.

We have Trinidad and Venezuelan series of *Meroncidius atrispinosus* Bruner, a larger insect but in many ways resembling the present species. The armament of the genicular lobes and dorso-caudal margin of the median tibiae and characters of the male genitalia show that that insect is not a member of *Meroncidius*, but is either a very aberrant species of *Idiarthron* or represents an undescribed and closely related genus.

[50] Brunner's *I. subnotatum*, described from females, is an uncertain entity. The Costa Rican material may represent a large and pale example of *atrispinum*, the Colombian possibly a distinct species. If valid, that species is smaller than *major*. Description of new species based on females is most unsatisfactory in this group.

Type: ♂; Fort Davis, Canal Zone, Panama. July 5, 1924. (N. Banks.) [Museum of Comparative Zoology.]

Size large for the genus; form moderately robust, normal. Fastigium slightly longer than broad, concave dorsad with apex and areas above lateral ocelli forming three small rounded projections of equal size. Proximal antennal joint distad with an internal triangularly, spiniform production. Pronotum thickly granulose, principal sulcus deep, cephalic margin of disk scarcely produced mesad but there thickened. Tegmina and wings extending slightly beyond apices of caudal femora; the stridulating area of the former small, as is usual in the genus. Ultimate tergite with two dorso-lateral horns directed dorsad and slightly incurved; surface weakly triangularly impressed above the supra-anal plate, caudal margin transverse. Supra-anal plate small, as long as proximal width, triangular with apex narrowly truncate and terminated on each side in a small node; its dorsal surface deplanate in about median third, the lateral thirds declivent. Cerci stout, rather short, incurved, rounded distad with apex gradually produced internally, conical, terminating in a small stout spine. Subgenital plate strongly produced, the produced portion with lateral margins thickened, the apical emargination between these slightly deeper than wide, the slightly projecting style sockets thus formed dorsad weakly and roundly produced externally and bluntly toothed internally.[51] Styles very elongate, flat dorsad and ventrad. Femora with genicular lobes unarmed except the internal of the median femora which bear a stout, straight spine; ventro-internal of cephalic and ventro-external of median and caudal femora armed with stout black spines, (the former with 4, the latter with 7 of these). Cephalic tibiae deplanate and unarmed dorsad; the auditory foramina moderately conchate, distinctly more so than is usual in the genus. Median tibiae with dorso-internal margin armed with (4) small spines.

General coloration cinnamon brown, tegmina darkened in stridulating area and in small spaces at intersections of veins and their branches in the other fields. Wings evenly suffused with cinnamon brown, the veins slightly more tawny toward the anterior margin. Coxae margined with black. Sutures of mesosternum and metasternum blackish brown. Ventral femoral spines black, paler subapically in an inconspicuous area.

Length of body (abdomen produced) 37, length of pronotum 8.8, caudal width of pronotal disk 4.9, length of tegmen 36.7, greatest tegminal width 8, length of style 6.4, length of caudal femur 25 mm.

[51] This is apparently a distinctive specific feature.

Idiarthron incurvum (Stål)

1875. *M[eroncidius] incurvus* Stål, Bih. till K. Svenska Vet.-Akad. Handl., III. No. 14, p. 41. [♂; Chiriqui, Panama.]

Chorcha, Chiriqui, April, 1914, 1 ♂, 1 ♀, [Hebard Cln.]. Panama, 2 ♂, 1 ♀,[52] [U.S.N.M.].

The Chorcha female measures as follows; length of body 37, length of pronotum 9.1, caudal width of pronotal disk 5, length of tegmen 36.5 (estimated, apices damaged), width of tegmen 9.5, length of caudal femur 26.2, length of ovipositor 22 mm.

Recorded from Venezuela and the upper Amazon, we question the validity of these South American records and particularly the latter. The genus is largely Central American.

Bliastes banksi[53] new species (Pl. XX, fig. 8.)

This interesting insect is nearest *B. atrifrons* Brunner, described from Chiriqui. Saussure and Pictet have described a topotypic male of that insect, the description of which is found to differ in the dark occiput, pronotum without dark dorsolateral stripes, fewer femoral spines, pyramidal supra-anal plate, less deeply emarginate subgenital plate and longer styles.

Type: ♂; Barro Colorado Island, Canal Zone, Panama. June 23, 1924. (N. Banks.) [Museum of Comparative Zoology.]

Size small, form moderately robust but graceful. Fastigium strongly bilobate proximad above the large lateral ocelli, remaining portion narrowly triangular, sulcate dorsad to near apex which projects almost as far as do the antennal scrobes. Face nearly smooth, with no distinct carinae laterad. Proximal joint of antennae armed disto-internally with a small tooth. Pronotum with cephalic margin convex and bearing a median tubercle; surface weakly wrinkled and sub-tuberculate, cut deeply by the principal sulcus and by the first sulcus particularly dorso-laterad, a short medio-longitudinal carina indicated at caudal margin of metazona and a medio-longitudinal sulcus at principal sulcus. Tegmina and wings surpassing apices of caudal femora by a moderate distance, the stridulating area of the former small. Ultimate tergite with surface convex, roundly produced but with an ample U-emargination mesodistad, into which fits the vertical supra-anal plate. That

[52] Recorded as *Cocconotus ignobilis* Brunner, by Rehn; Trans. Amer. Ent. Soc., XXIX, p. 29, (1903).

[53] Named in honor of Nathan Banks, Curator of Entomology at the Museum of Comparative Zoology, who secured an interesting series of Orthoptera during his stay in the Canal Zone, which we have kindly been allowed to study.

plate is almost quadrate, slightly longer than wide, with disto-lateral angles broadly rounded; proximad its surface is weakly convex, there divided by a broad and very shallow medio-longitudinal sulcus. Cerci stout, moderately elongate, bent slightly inward distad, the rounded apices pinched dorsad and ventrad and armed disto-internally with a small thorn-like tooth, directed at right angles to the shaft. Subgenital plate moderately produced, narrowing rather evenly throughout, ventral surface deplanate between carinae which converge caudad to the styles, narrow lateral portions reflexed and moderately concave; apex narrow, the small V-emargination between the styles no deeper than wide. Styles simple, cylindrical, each nearly three times as long as the depth of the emargination. Genicular lobes of cephalic and median femora with external unarmed and internal supplied with a small, straight spine; all those of caudal femora supplied with a small, incurved spine. Cephalic tibiae deplanate and unarmed dorsad, the auditory foramina subconchate. Median tibiae unarmed dorsad.

General coloration ochraceous tinged with brown, deepening to dresden brown on occiput and to buckthorn brown on pronotal disk. Entire face and all but distal portion of labrum shining black, the fastigia chestnut brown. Antennae dresden brown with traces of small, irregular, paler annuli proximad. Pronotum with a heavy band of blackish brown margining the lateral lobes dorsad on each side, these bands widening cephalad of the first sulcus and spreading on the disk to meet along its cephalic margin. Tegmina with veins and entire stridulating area rich cinnamon brown, all veinlets buff, those of the marginal field particularly pale, with irregular but some rather large intervals between prouts brown, this giving a frosted and tessellate effect. Wings transparent, uniformly and moderately suffused with mummy brown, the veins themselves slightly darker. Limbs buffy, sub-annulate and marked with weak brownish suffusions; spines pale with russet apices.

Length of body 25.7, length of pronotum 6.1, caudal width of pronotal disk 3, length of tegmen 26.3, width of tegmen 5, length of subgenital plate 5.8, length of style 1.8, length of cephalic femur 8.2, length of caudal femur 17.2 mm.

Bliastes bradleyi new species (Pl. XX, fig. 9.)

This species agrees closely with *B. submarginata* (Walker) described from Pará, Brazil. Comparison with a topotypic female in the Academy collection shows that *bradleyi* differs in the ovipositor which is more recurved distad (unusually straight for the genus in *submarginata*), while the female subgenital plate is much smaller and narrower, with apical emargination

narrowly U-shaped, even smaller and much narrower. The only differences in coloration in *bradleyi* are the paler auditory foramina margined with blackish brown, evenly suffused occiput and more darkened caudal margin of the pronotal disk.

This species differs widely, however, in armament of the genicular lobes; the cephalic-internal of the cephalic femora bearing only a vestigial spine in *bradleyi* but a strong spine in *submarginata*, both of the caudal femora unarmed in *bradleyi* but both unispinose in *submarginata*. Likewise the first antennal joint is unarmed in *bradleyi*, but supplied with a stout disto-internal spine in *submarginata*.

Type: ♀; Barro Colorado Island, Canal Zone, Panama. March 26 to 31, 1924. (J. C. Bradley.) [Hebard Collection, Type No. 1081.]

Size large for the genus; form moderately robust, elongate cylindrical. Fastigium decidedly bilobate above the large lateral ocelli, remaining portion narrowly acute shield-shaped, sulcate dorsad to near apex, which is well surpassed by the antennal scrobes. Face almost smooth, with faint traces of lateral carinae. Proximal antennal joint unarmed disto-internally. Pronotum with cephalic margin convex and bearing mesad a blunt median tubercle; surface strongly granulose, first sulcus weak, principal sulcus decided with a short medio-longitudinal carina there. Tegmina and wings surpassing caudal femora by a considerable distance. Supra-anal plate rounded with faint indication of a triangular outline, its dorsal surface concave. Ovipositor stout, acute, weakly recurved; lateral surfaces of dorsal valves showing disto-ventrad five short, vertical ridges (such do not occur in *submarginata*); dorsal margin feebly serrulate for some distance mesad, ventral margin showing mere traces of such distad. Subgenital plate small, longer than wide, triangular with blunt apex finely U-emarginate. Genicular lobes of femora armed as follows; external of cephalic and median and both of caudal unarmed, internal of cephalic with the blunt base of a vestigial spine showing, of the median similar on one side and with a small spine on the other.[54] Ventro-cephalic margins of femora alone armed with moderately stout spines (cephalic 2 and 3, median 3 and 3, caudal 5 and 5).

General coloration clay color, the tegmina uniform tawny olive, the wings evenly suffused with mummy brown. Head immaculate except as follows; occiput suffused with bister, becoming blackish on fastigium; first antennal joint narrowly

[54] Atrophy in the armament of the genicular lobes is much stronger in this species than is usual in *Bliastes*.

margined disto-internally with dark brown; jaws with margins deepening to russet. Pronotum with cephalic margin entirely black, disk with caudal margin mesad and laterad and the short medio-longitudinal sulcus also black. Femora slightly darkened pre-apically to tawny olive. Cephalic and median tibiae tawny olive, the auditory foramina and proximal area clay color, narrowly margined proximad and distad and with an intervening line of black. Spines black but with no proximal suffusion, those of cephalic and median tibiae paler, brown. Ovipositor ochraceous buff proximad, thence blackish chestnut brown with a median invasion of tawny.

Length of body 43.3, length of pronotum 8.1, caudal width of pronotal disk 4.8, length of tegmen 42.2, width of tegmen 9, length of cephalic femur 11.3, length of caudal femur 23.3, length of ovipositor 20.8, median width of ovipositor 3.7 mm.

Parabliastes vermiculatus Saussure and Pictet

1898. *Parabliastes vermiculatus* Saussure and Pictet, Biol. Cent.-Amer., Orth., I, p. 430. [♂; Chiriqui Volcano, Panama.]

Barro Colorado Island, Canal Zone, July 28, 1924, (N. Banks), 1 ♀.

Panama, 1 ♂, [Hebard Cln.].

The previously unknown female has the ovipositor evenly narrowing and gently curved dorsad to its apex, the dorsal margin very feebly serrulate to near the base. The subgenital plate has the lateral margins very broadly convex-convergent to the apex, where they are suddenly strongly convex, meeting to form a small V-shaped emargination. Unlike the type as described, the antennae are finely annulate with dark brown.

Length of body ♂——, ♀ 36.7; length of pronotum ♂ 6.4, ♀ 6.9; length of tegmen ♂ 36.2, ♀ 37.9; proximal width of tegmen ♂ 6.8, ♀ 7.7; length of caudal femur ♂ 18.3, ♀ 19.8; length of ovipositor 16 mm.

Cocconotus degeeri (Stål)

1860. *Meroncidius degeeri* Stål, Kongl. Svenska Freg. Eugenie's Resa, Zool., I, p. 322. [♀; San José Island, [Pearl Islands,] Panama.]

France Field, Cristobal, Canal Zone, July 7, and August 18, 1920, (M. Hebard; in large-leaved shoots of undergrowth in dense forest; at night, eating in heavy reeds fifteen feet high),[55] 3 ♂, 1 ♀.

[55] This specimen made no attempt to escape and stridulated faintly when siezed.

Pinogana, Darien, December, 1915, (Muñoz), 1 ♂, 1 ♀.

The description of *C. wheeleri* fits that of the present insect throughout except where differences between these closely related species are noted. Unfortunately *degeeri* was not originally, or subsequently, described in detail. As the genotype, many of the characters, particularly the general form of the genitalia and the limb armament, are most important in properly understanding the genus *Cocconotus* Stål.

The three median of the five vertical blackish brown stripes on the face are more or less confluent in the series, though not at all so in a very large specimen of *degeeri* which we have recently recorded from Boca Murindo, Intendencia del Chocó, Colombia.

The extremes of the present series measure as follows; length of body ♂ 35 to 38.7, ♀ 36 and 41.7; length of pronotum ♂ 7.1 to 7.9, ♀ 7.2 to 8.3; length of tegmen ♂ 35 to 37, ♀ 40.5 and 41.7; greatest tegminal width ♂ 8 to 8.2, ♀ 8.2 and 8.5; length of caudal femur ♂ 20.8 to 22.2, ♀ 22 and 23.7; length of ovipositor 18.2 and 20.2 mm.

This handsome, genotypic species has been recorded from the Volcano of Chiriqui, Matachin, Rio Cianati, Lake Pita and Punta di Sabana, Darien, Panama, but confusion with the closely related *C. wheeleri* here described, has probably occurred.

Cocconotus wheeleri[56] new species (Pl. XX, figs. 10 and 11.)

This insect is of considerable interest in being generally identical with *C. degeeri* (Stål), differing only in the smaller size, differently shaped supra-anal plate in both sexes and distinctive male cerci.

It shows that, in this phylum, the striking facial markings are sometimes the same in distinct species.

Type: ♂; Ancon, Canal Zone, Panama. (W. M. Wheeler.) [Hebard Collection, Type No. 1065.]

Size rather small; form moderately robust, though slender when compared with the average in this section of the Pseudophyllinae. Head as in *degeeri*, the face very slightly shorter. Proximal joint of antennae with a mere node on distal margin internally. Pronotum with surface very finely but thickly rugulose-granulose, this weak on lateral lobes caudad; first

[56] Named in honor of the collector of the type, Dr. William M. Wheeler, who more than once has sent us very interesting specimens of Orthoptera which he had secured.

sulcus distinct but not deep, principal sulcus deep. Tegmina and wings extending well beyond apices of caudal femora; stridulating area of the former small, roundly produced beyond sutural margin, with a distinct indentation just caudad of the stridulating vein. Ultimate tergite convex declivent caudad, showing some impression above the supra-anal plate, the suture which joins these plates broadly concave. Supra-anal plate small, slightly longer than proximal width, very deeply and heavily medio-longitudinally sulcate, the sides strongly pinched upward meso-distad so that the narrowly truncate apex is very slightly wider than the point of least width.[57] Cerci with shaft proximad stout and cylindrical, then with distal portion bent dorsad at a right angle to it and equally heavy, the external surface inflated and apex broadly rounded, ventro-proximad with a straight chitinous cultriform ridge, the internal surface of the distal portion produced ventro-proximad into a small spine, the apex of which lies near and slightly within the distal extremity of the cultriform ridge.[58]. Subgenital plate strongly produced, the production narrow and of subequal width in distal portion, terminating in four small, stout, dorsal teeth, between the lateral two of which on each side are inserted the small, simple, cylindrical styles, which are about three times as long as broad; the apex of the plate not emarginate between the two median teeth. Femora with genicular lobes rounded, the internal of the median alone bearing a small, straight spine. Femora with ventro-cephalic margins of cephalic and median armed with (2 to 4) small, stout spines, and of caudal with (5 to 7 in the series) larger, stout spines. Cephalic tibiae deplanate and unarmed dorsad, the lateral margins there slightly raised; auditory foramina somewhat flattened conchate. Median tibiae unarmed dorsad.

Allotype: ♀; Las Cascadas, Canal Zone, Panama. (A. H. Jennings.) [Hebard Collection.]

[57] The form of this plate is found to be extremely important not only as a specific character but also as a guide in associating the sexes of forms of this group.

In *degeeri* the supra-anal plate is similar, but the medio-longitudinal sulcus is broader, the sides less pinched upward and gradually converging to the similarly narrowly truncate apex, so that the general outline of the plate is more nearly triangular.

[58] In *degeeri* the cercus is as long and is stout though decidedly less heavy, curving moderately dorsad with this curvature strongest mesad, externally evenly convex to the moderately blunt apex, the distal portion produced ventro-proximad in a small similar spine, but no cultriform ridge being developed.

Agrees closely with male; size slightly larger, apparently averaging distinctly smaller than this sex of *degeeri*. Tegmina and wings quite as fully developed. Supra-anal plate as described for male (and important in locating material of this sex of this and related species). Ovipositor moderately broad, very gradually curved dorsad to the acute apex; dorsal margin in more than distal half and ventral margin distad very finely and weakly serrulate; polished lateral surfaces with five short, vertical ridges distad on dorsal valves, three mesad and two preceding them on the ventral margin of those valves. Subgenital plate rounded trigonal, longer than broad, with apex feebly bilobate, due to a minute median emargination.

In coloration this species and *degeeri* are almost identical. The five dark facial stripes are, however, very sharply defined in the five examples of *wheeleri* before us, which stripes show a tendency to fuse in frequent individuals of *degeeri*.

General coloration of head, lateral lobes of pronotum, body and limbs ochraceous buff tinged with buckthorn brown. Occiput and vertex suffused with blackish brown; face with five striking and sharply defined vertical stripes of the same, the apices of the mandibles and of the labrum also blackish brown. Pronotum dorsad blackish brown, this narrowed in median portion and there sometimes paler, continued downward on cephalic and caudal margins of lateral lobes as a narrow black margin. Tegmina quite uniform buckthorn brown, the thick network of veinlets in proximal half of marginal field light lumiere green. Wings evenly and not strongly suffused with prouts brown. Spines of limbs black, except those of cephalic and median tibiae which are paler, dark brown. Ovipositor shining, ochraceous buff, broadly margined distad with chestnut brown.

The measurements of the extremes of the female paratypes follow those of the male type. Length of body ♂ 30, ♀ 26.7 to 32.5; length of pronotum ♂ 6.4, ♀ 7 to 7.1; caudal width of pronotal disk ♂ 3.2, ♀ 3.8 to 4.2; length of tegmen ♂ 30.1, ♀ 34.4 to 35.3; greatest tegminal width ♂ 6.7, ♀ 7 to 7.3; length of cephalic femur ♂ 8.8, ♀ 9.7 to 10.1; length of caudal femur ♂ 17.2, ♀ 20.8 to 21; length of ovipositor 17.3 to 17.4 mm.

Specimens Examined: 6; 1 male and 5 females.

Barro Colorado Island, Canal Zone, July 23 to August 13, 1924, (N. Banks), 2 ♀, *paratypes*.

Paraiso, C. Z., January 28, 1911, (E. A. Schwarz), 1 ♀, *paratype*.

Las Cascadas, C. Z., (A. H. Jennings), 2 ♀, *allotype* and *paratype*.

Ancon, C. Z., (W. M. Wheeler; from *Cordia geraschanthus* Jacq., a tree of the Ehretia Family), 1 ♂, *type*, [Hebard Cln.].

Thamnobates subfalcata Saussure and Pictet

1898. *Thamnobates subfalcata* Saussure and Pictet, Biol. Cent.-Amer., Orth., I, p. 437, pl. 20, figs. 30 to 32. [♂, ♀; Chiriqui Volcano, Panama.]

Barro Colorado Island, Canal Zone, June 22, 1924, (N. Banks), 1 ♀.

Porto Bello, March 15, 1911, (A. Busck), 1 ♂.

This species is tawny in general coloration, with face paler. The tegmina are tawny, the male with stridulating area caudad of the stridulating vein solidly blackish brown, the sutural margin thence and the distal margin narrowly buffy.

These specimens measure: length of body ♂ 21.5, ♀ 21.2; length of pronotum ♂ 6.6, ♀ 6.1; caudal width of pronotal disk ♂ 3.8, ♀ 4.5; length of tegmen ♂ 21, ♀ 22.8; width of tegmen ♂ 5.8, ♀ 5.8; length of caudal femur ♂ 14.8, ♀ 15.3; length of ovipositor 13 mm.

GOETHALSIELLA[59] new genus

This genus is erected to include *Goethalsiella tridens* here described, while another yet undescribed species is represented by a female before us, from which we secure the characters given for that sex. It is nearest *Ischnomela* Stål, that genus differing in the more slender form, longer limbs, fastigium with narrow, rounded, elongate lobiform proximal portion more conspicuous, more elongate organs of flight, pronotum with distinct though not deep humeral sinus and cephalic tibiae armed dorso-distad both externally and internally with a spine.

The specialization of the proximal abdominal tergite and genitalia of the males of these genera shows a general similarity of type very distinct from that of other allied genera.

Form moderately slender. Limbs elongate. Fastigium with apical portion very small, but more prominent than in *Ischnomela*, surpassed by the antennal scrobes. Face elongate. Proximal antennal joint unarmed. Pronotum short, semicylindrical, truncate caudad, principal sulcus prominent and strongly convex caudad as in *Ischnomela*, but humeral sinus scarcely suggested by a broad and very feeble concavity or a flattening[60] of the dorsal portion of the caudal margin of the lateral lobes. Tegmina and wings very slightly or greatly[60] reduced. Metasternal foveolae running together to form a single impressed

[59] Named in honor of George Washington Goethals, Chief Engineer of the Panama Canal, 1907 to 1914.

[60] In the Costa Rican species.

area. Male proximal tergites specialized. Male cerci small. Male subgenital plate deeply cleft, with styles small. Ovipositor elongate, straight, unarmed; dorsal margin straight, ventral margin curving very gradually to the acute apex. Femora with internal genicular lobe of median and both of caudal spined, those of cephalic unarmed or supplied with a vestigial spine.[60] Cephalic and median femora terete and unarmed ventrad, caudal with ventro-external margin armed with a few small spines. Cephalic tibiae with dorsal surface sulcate and armed only with a disto-internal spine; auditory foramina conchate.

The pleura have lines of buff, a feature apparently of generic significance, as are the black markings on the coxae and pleura in *Idiarthron.*

Goethalsiella tridens new species (Pl. XX, fig. 12.)

This insect is distinctive in its rich dark coloration, with very dark apices of the femora and green veinlets of the marginal field of the tegmina proximad.

Type: ♂; Barro Colorado Island, Canal Zone, Panama. (C. W. Dodge.) [Museum of Comparative Zoology.]

In addition to the generic characters we note the following. Size rather small, form more slender than is usual in this section of the subfamily but decidedly more robust than in *Ischnomela gracilis* Stål. Buffy fleck of median ocellus prominent but not over half as wide as proximal antennal joint. Head and pronotum glabrous, the latter weakly rugulose. Tegmina and wings reaching to near apex of abdomen, decidedly surpassed by the caudal femora; sinistral stridulating field of former unusually rugulose, the veinlets making the stridulating vein uneven as in *I. gracilis.* Metanotum lobate meso-caudad, this produced as a finger projecting over the succeeding tergite; the two first tergites produced meso-caudad but triangularly and to a lesser degree, the latter of these with a rounded node dorsad on each side.[61] Ultimate tergite truncate, weakly impressed and sulcate meso-distad. Supra-anal plate small, declivent, rounded trigonal, very deeply medio-longitudinally sulcate. Two plates between cerci heavy, produced, with uncinate apices directed dorsad. Cerci small, rather slender, very feebly incurved to the apical portion, which is very feebly curved outward, that portion armed internally with three small teeth. Subgenital plate ample proximad, slenderly produced and narrowly cleft distad

[61] The meso-caudal projections are erect and nodes are present on the third as well as the second tergite in *I. gracilis.*

a distance equalling about one-third of the produced portion, the apices thus formed broadening slightly so that they are almost attingent distad, each surmounted by a slender style, equalling in length the emargination. Auditory foramina of cephalic tibiae slightly more strongly conchate than in the Costa Rican species or *I. gracilis*. Caudal femora with ventro-external margins armed with (4 and 5) small, delicate spines.

General coloration of body auburn, face paler with ocelli conspicuously buff. Occiput blackish brown; proximal antennal joints slightly paler, thence chestnut. Pronotum dorsad, abdominal sternites and femora rich chestnut, the latter becoming blackish brown distad. Spines of caudal femora chestnut. Tibiae dresden brown, their spines slightly darker. Tegmina prouts brown with veins chestnut and veinlets paler, buffy but inconspicuous except those of marginal field proximad which are strikingly biscay green. Pleura with lines of buffy.

Length of body 31, length of pronotum 6.2, caudal width of pronotal disk 4.5, length of tegmen 25.8, width of tegmen (beyond stridulating field which projects roundly and strongly) 6.1, length of cephalic femur 10.2, length of caudal femur 27.8 mm.

Ischnomela gracilis Stål

1873. *Ischnomela gracilis* Stål, Öfv. K. Svenska Vet.-Akad. Förh., xxx, p. 49. [♂; Cartagena, Colombia.]

Bocas del Toro, July 1 to 10, 1908, (Wirt Robinson), 1 ♀.
Gatun, Canal Zone, July 25 to 31, 1916, (D. E. Harrower), 1 ♂.
Porto Bello, March 2 and 10, 1911, (A. Busck; male on *Heliconia* leaves), 1 ♂, 1 ♀.

Striking specialization of the male abdomen dorso-proximad has not previously been noted. The metanotum is inflated meso-caudad and produced caudad in a slender triangular projection, while the first and second tergites have each a vertical, straight, finger-like projection mesad at their caudal margins, these three projections all being subchitinous at their apices. In addition the second and third abdominal tergites each have a prominent rounded node dorsad on each side. Such organs are probably comparable to those described for species of the Tettigoniid genus *Arethaea* Stål and are very possibly glands, having a secondary sexual function.

This handsome slender species has further been recorded from Chiriqui, Bugaba and Tintin, Panama, and from Medellin and Bogotá (probably from adjacent lower country), Colombia.

Leptotettix gigliotosi Griffini

1896. *L[eptotettix] giglio-tosi* Griffini, Boll. Mus. Zool. Anat. Comp. Univ. Torino XI, No. 232, p. 23. [♂, ♀; Punta di Sabana, Rio Lara and Rio Cianati, Darien.]

Barro Colorado Island, Canal Zone, June 23 to July 27, 1924, (N. Banks), 1 ♂, 2 ♀.

Frijoles, C. Z., July 10, 1924, (N. Banks), 2 ♀.

Porto Bello, March 10 to 19, 1911, (A. Busck), 2 ♂, 2 ♀, 1 large juv. ♂.

Scopiorus fragilis new species (Pl. XX, figs. 13 and 14.)

This delicate, green insect is near *S. nigridens* Stål, differing from a Costa Rican male of that species before us in the genitalia, the immaculate antennae, smooth (not microscopically irregularly rugulose) pronotum and in the femoral armament, the spines being smaller and only those of the cephalic femora dark.

Type: ♂; Gatun, Canal Zone, Panama. July 17 to 23, 1916. (D. E. Harrower.) [Hebard Collection, Type No. 1060.]

Size medium for the genus, form slender, structure delicate. Fastigium horizontal, slender, strongly sulcate to near the sharply rounded apex, which briefly surpasses the antennal scrobes. Pronotum smooth, impressions scarcely indicated, first transverse sulcus linear on disk and cut by the medio-longitudinal carina, which in turn is cut by the heavier principal sulcus, that sulcus extending to ventral margin of lateral lobes; metazona alone showing very feeble rounded angulation between disk and lateral lobes. Tegmina elongate and narrow, the narrowly rounded apices considerably surpassing the wings which are moderately reduced, cycloidal, probably useful as parachutes but incapable of flight. Mesosternal lobes triangularly produced, adjacent median trochanters coarsely bidentate; metasternal lobes briefly produced as arcuate lamellae, adjacent caudal trochanters with a node and a very blunt and coarse apical tooth. Abdominal tergites simple, unarmed. Ultimate tergite produced mesad in a horizontal lamella which is slightly longer than broad, its sides very weakly convex and divergent to the weakly bilobate apex. Cerci reaching almost as far caudad; simple, cylindrical, tapering to the incurved apices. Between the cerci are two more slender, recurved appendages of nearly equal length, apparently developed from the ventral podical plates, their dorsal surfaces thickly supplied with slightly reflexed spiniform hairs. Subgenital plate elongate, decidedly produced, its ventral surface sharply and deeply medio-longitudinally concave, this broadening distad; the whole contour however convex, due to the roundly reflexed lateral portions; produced portion gradually narrowing and then gradually widening to the broadly concave distal margins, the latero-

caudal portions of which are directed dorso-externally and triangularly produced with apices rounded. Limbs extremely elongate and slender. Femora with ventro-cephalic margins armed with very small distal spines (cephalic 5 and 6, median 0 and 1, caudal 1 and 2); genicular lobes rounded, internal of median femora bearing a minute mucronate tooth, all of caudal femora bearing a single blunt tooth. Median tibiae unarmed dorsad.

General coloration rivage green. Eyes liver brown. Tegmina with costal margin and some veins in discoidal field (due to discoloration ?) narrowly buffy, humeral vein whitish to meso-distal point where that vein suddenly leaves the discoidal vein to run to the costal margin. Pronotum with the following minute flecks: of buff yellow, mesad and at lateral extremities of disk on cephalic and caudal margins; of black, at lateral extremities of first sulcus situated at juncture of disk and lateral lobes, one before and one behind principal sulcus on disk just before lateral margins on each side, one in principal sulcus on lateral lobes just below those margins and one larger fleck mesad in principal sulcus. Cephalic femora with a row of blackish brown flecks mesad along the internal and external surfaces.

We have also examined two male paratypes secured by Nathan Banks in the Canal Zone, one at Fort Davis, July 5, 1924, the other from Barro Colorado Island, July 14, 1924; the former, here measured after the type, being decidedly the larger.

Length of body 25.6 to 29.8, length of pronotum 4.8 to 5.8, caudal width of pronotal disk 3 to 4, length of tegmen 23.3 to 29, width of tegmen 5 to 5.8, length of cephalic femur 11 to 13.8, length of caudal femur 22 to 25 mm.

Xestoptera cornea Brunner

1895. *Xestoptera cornea* Brunner, Monogr. der Pseudophyll., p. 244. [♀; Oaxaca, Mexico.]

Barro Colorado Island, Canal Zone, August 30, 1924, (N. Banks), 1 ♂.

This male apparently shows the proper proportions for this sex of *cornea*, the Colombian *X. cincta* Brunner being more elongate. The three proximal antennal joints are, however, blackish brown distad in the present specimen, as described for *cincta*. The tegmina are shining green and heavily corneous. The wings are tinted with flesh color

The stridulating field of the sinistral tegmen is entirely coriaceous, caudad of the stridulating vein made up of a network of coarse flattened veinlets. The ultimate tergite is

rather thickly supplied with long silky hairs and is concave mesad. The cerci are short, cylindrical, the rounded apex armed with a tooth directed inward at a right angle to the shaft. The subgenital plate is roundly emarginate distad between the straight, simple styles.

Length of body 31.5, length of pronotum 6.9, caudal width of pronotal disk 5.3, length of tegmen 33, greatest tegminal width 10.8, length of caudal femur 25.3 mm.

Mimetica marmorata Saussure and Pictet

1898. *Mimetica marmorata* Saussure and Pictet, Biol. Cent.-Amer., Orth., I, p. 453, pl. 22, figs. 10 and 11. [♀; Caché, Costa Rica; Tolé, Panama.]

Bugaba, Chiriqui, (W. Schaus), 1 ♀, [Hebard Cln.].

This individual agrees closely with *M. brunneri* S. and P., except that the tegmina have the oblique distal portion of the sutural margin straight, not undulate as in that insect. It is quite possible that *marmorata* may prove to be a synonym of *M. viridifolia* Brunner.

Until series can be secured to determine how much individual variation occurs, as well as the degree of contrast between the sexes in species of *Mimetica*, we believe that new species should be proposed only after very careful consideration of all data available. It appears very possible that already too many species have been described of the phylum to which the present insect belongs.

Length of body 25, length of pronotum 7.2, caudal width of pronotal disk 4.4, length of tegmen 35.7,[62] greatest tegminal width 22.8, greatest width of tegminal costal field 13.2, length of caudal femur 20.8, length of ovipositor 13.1 mm.

COPIPHORINAE

Caulopsis microprora Hebard

1926. *Caulopsis microprora* Hebard, Trans. Amer. Ent. Soc., LII, p. 333, pl. 21, fig. 12. [♂, ♀; localities here listed, and Boca Murindo, Aracataca and Cordoba, Colombia.]

Gatun, Canal Zone, August 22, 1916, (D. E. Harrower), 1 ♀.
Barro Colorado Island, C. Z., July 19, 1924, (N. Banks), 1 ♂.
Limon Plantation, Rio Chagres, July 14, 1918, (Dietz and Zetek; in sweeping from corn field), 3 ♀.
Pinogana, Darien, December, 1915, (Muñoz), 1 ♂.

[62] Estimated; apices damaged in this specimen.

NEOCONOCEPHALUS Karny

Though this is the largest and most widely distributed genus of the American Copiphorinae, it is poorly represented in Panama, three widely distributed and common species alone occurring in the present series.

Though there are numerous less widely distributed species in many regions, we strongly question many of the records by Redtenbacher and Saussure and Pictet from Central America. Use of color characters, often of no specific value and rarely of more significance than an aid to show the usual condition developed in a species and failure to recognize that both a brown and a green color phase appears in most species, has resulted in much confusion. Persistent adherence to such in the monographs by Redtenbacher and Karny, though large series were studied, has left the problem more clouded than ever, with many synonyms added and enough specimens incorrectly recorded to make the definition of the actual known limits of distribution of many of the species a difficult task.

The following key is intended to be used only as an aid in separating the three species before us from Panama.

A. Vertex slightly longer than wide, usually narrowing slightly to the rather broadly rounded apex. Pronotum having a less rounded appearance. Stridulating field of male tegmen lacking a longitudinal dark stripe sinistrad.

B. Size averaging smaller, medium for the genus; form quite slender. Vertex slightly more produced, distinctly longer than wide. Tegmina in brown phase usually with costal margin darkened. Male tegmina with stridulating vein short, the vein above it developed from it sinistrad and gradually diverging from it dextrad. Jaws usually moderately richly colored. Caudal femora with dark markings at bases of spines not large. *maxillosus* (Fabricius)

BB. Size averaging larger, large for the genus; form robust. Vertex little produced, length equal to width or slightly longer. Tegmina never showing darkening of costal margin, but with a pale line usually well indicated before the veinless marginal portion there. Male tegmina with stridulating vein very long, the vein above it adjacent to it throughout. Jaws usually richly colored. Caudal femora with dark markings at bases of spines usually large and conspicuous. *affinis* (Beauvois)

AA. Vertex usually wider than long, never narrowing, with apex very broadly rounded. Pronotum having a more rounded appearance. Stridulating field of male tegmen with a longitudinal dark stripe sinistrad. (Size large, form robust. Tegmina in brown phase usually with costal margin darkened, such very rarely developed in green phase. Male tegmina with stridulating vein short. Jaws not richly colored. Caudal femora with dark markings at bases of spines very small or absent. *triops* (Linnaeus)

Neoconocephalus maxillosus (Fabricius)

1775. [*Locusta*] *maxillosa* Fabricius, Syst. Ent., p. 284. [America.]

Fabricius' description of this insect is very unsatisfactory, that of Serville, based on females from Brazil and Cayenne, enabling us to locate the species. Under this name Redtenbacher has almost certainly placed material of more than one species, a frequent occurrence in his monograph of 1891. Kirby, in 1906, has referred a number of names to synonymy here, but of these *lanceolata* and *affinis* of Beauvois from San Domingo we are convinced, represent the species which has been generally recognized as *guttatus* (Serville), while Walker's *viridator* from Honduras and *abbreviatus* from an unknown locality are more probably synonyms of *triops* (Linnaeus). There remains *muticus* of Redtenbacher, described from Cuba and St. Vincent, which may represent the present species, but in large West Indian collections now at hand, no material of *maxillosus* is included excepting a large series from Jamaica. We have recently placed Bolivar's *heteropus* as a synonym.[63]

Gatun, Canal Zone, July 12 to August 22, 1916, (D. E. Harrower), 4 ♂, (all green), 2 juv. ♂.

Ancon, C. Z., August 6, 1924, (N. Banks), 1 ♂, (green); November 12 and 13, 1913, (M. Hebard), 6 ♂, 1 ♀, (all green except one brown male); (J. Zetek), 1 ♀, (brown).

Panama City, 1912, (J. Zetek), 1 ♂, 1 ♀, (brown).

The limits of this widespread species, as represented by material before us, extend north to the Island of Jamaica; San Rafael, Vera Cruz and Tepic, Mexico. Material was recorded from Punta di Sabana, Darien, Panama, as *muticus*, by Griffini in 1896, as was a specimen from Carrillo, Costa Rica, by Rehn in 1905. Southward we have examined material from Colombia, Brazil and British Guiana.

[63] Trans. Amer. Ent. Soc., LII, p. 336, (1927).

Neoconocephalus affinis affinis (Beauvois)

1805. *Locusta affinis* Beauvois, Ins. Rec. Afr. et Amer., p 219, pl. 7, fig. 5. [♀, San Domingo.]

We have recently placed Serville's *guttatus* as a synonym and Bolivar's *crassus* as a race of this species,[64] Redtenbacher's *nigropunctatus* having been assigned to synonymy under *crassus* at a prior date.[65]

David, Chiriqui, August 10, 1922, (D. E. Harrower), 1 ♂, (green), [A.N.S.P.].

France Field, Canal Zone, July 7, 1920, (M. Hebard; stridulating in grasses of swampy area at night), 1 ♂, (green).

Gatun, C. Z., July 19 to August 22, 1916, (D. E. Harrower), 12 ♂, 9 ♀, (green, except one male and two females brown), 2 juv. ♂, 4 juv. ♀.

Barro Colorado Island, C. Z., July 31, 1921, (N. Banks), 1 ♂, (green).

Ft. Davis, C. Z., July 5, 1924, (N. Banks), 2 ♂, (one brown, one green).

Guamina, Rio Chagres, March 5, 1922, (G. H. H. Tate), 2 ♀, (green).

Porto Bello, February 27, 1911, (A. Busck), 1 ♂, (green).

The distributional limits of typical *affinis*, as shown by our material, are as follows. San Domingo, Hayti, Cuba, Jamaica, Panama and northern Colombia and Venezuela.

Neoconocephalus triops (Linnaeus)

1758. *Gryllus* (*Tettigonia*)] *triops* Linnaeus, Syst. Nat., Ed. 10, I, p. 430. ["Indiis," probably the West Indies.]

1891. *Conocephalus obscurellus* Redtenbacher, Monogr. der Conoceph., p. 397. [♂, ♀; Cuernavaca, Mexico[66]; Guatemala; Guita; Antilles; Venezuela; Nicaragua, and Cuba.]

1891. *Conocephalus nigrolimbatus* Redtenbacher, Monogr. der Conoceph., p. 401. [♂, Cuba.]

1891. *Conocephalus macropterus* Redtenbacher, Monogr. der Conoceph., p. 402. [♀; Mexico[67]; Martinique; St. Vincent; Cuba; San Francisco and Pernambuco, Brazil; Peru; Buenos Aires [, Argentina].]

[64] Trans. Amer. Ent. Soc., LII, p. 337, (1927).

[65] Proc. Acad. Nat. Sci. Phila., LXXVI, p. 223, (1924).

[66] We here select Cuernavaca, Mexico, as type locality of *obscurellus*, though all of Redtenbacher's originally included material may, in this case, represent material of the same species.

[67] We here select Mexico as type locality of *macropterus*. The South American records are probably based on material of one or more other species.

Through examination of very large series now before us we find that the brown phase of both *maxillosus* (Fabricius) and *triops* normally has the costal margin of the tegmina narrowly darkened and that this is weakly indicated or absent only in pale individuals of that color phase, though in the green color phase it is very rarely found.[68] This enables us to place *obscurellus* and *nigrolimbatus* in the present synonymy, while the Mexican material of *macropterus* we are convinced also represents specimens of *triops* having the fastigium not darkened. Considerable synonymy has been previously established.[69]

Bocas del Toro, July 1 to 10, 1908, (Wirt Robinson), 2 ♀, (green).

Gatun, Canal Zone, July 12 to August 22, 1916, (D. E. Harrower), 3 ♂, (two green, one brown).

Ancon, C. Z., July 8, 1924, (N. Banks), 1 ♂, (brown); November 12 and 13, 1913, (M. Hebard), 6 ♀, (all green).

The insect has been recorded from Punta di Sabana, Darien, as the synonymous *mexicanus*. In the Philadelphia collections we find the following material to represent *triops*, which has been recorded by Rehn. As *obscurellus* from Havana, Cuba; Barbados; Guadalajara and Cuernavaca, Mexico, and Tarbaca, Costa Rica, with Costa Rican specimens so labelled by Saussure. As *macropterus* from Montserrat; St. Lucia; Barbados, and Orizaba, Jalapa and Teocelo, Mexico (South American material so labelled by Bruner representing, however, a very distinct species). As *fuscostriatus* from Havana, Cuba. As *hebes* from Orizaba, Jalapa and Tacubaya, Mexico. As *maxillosus* from Bermuda (but not a Paraguayan female so recorded).

This insect is known northward to Oklahoma, the District of Columbia and Bermuda, and southward material is before us from Lima, Peru, on the Pacific coast and as far as British Guiana on the Atlantic. South of these localities we do not believe it will be found in South America, records of its synonyms from those regions being probably all based on similarly marked individuals of other species.

[68] Presence or absence of a similar marginal tegminal marking has been used to separate the Asiatic species *Euconocephalus varius* (Walker) from *E. nasutus* (Thunberg). There is, therefore, every reason to believe that *varius* is a synonym of *nasutus*. See Hebard, Proc. Acad. Nat. Sci. Phila., LXXIV, p. 240, (1922).

[69] See Rehn and Hebard, Trans. Amer. Ent. Soc., XL, p. 405, (1915).

Bucrates capitatus (DeGeer)

1773. *Locusta capitata* DeGeer, Mem. Hist. Ins., III, p. 455. [♀, unknown locality.]

Gatun, Canal Zone, July 28 to August 5, 1916, (D. E. Harrower), 1 ♂.

Ft. Davis, C. Z., July 5, 1924, (N. Banks), 1 ♂.

Canal Zone, 1917, (Lieut. Dunham), 1 ♀, [U.S.N.M.].

This handsome species has been recorded from Vera Cruz, Mexico, to Bahia, Brazil. Our series shows such considerable variation in length of the organs of flight and ovipositor, that the following measurements (in millimeters) are given.

♂	Length of body	Length of pronotum	Caudal width of pronotal disk	Length of tegmen	Length of caudal femur	Length of ovipositor
Gatun, Panama ...	35	10.3	6.8	44.6	25.5	——
Ft. Davis, Panama.	30.8	10.1	6.7	41.4	24	——
Venezuela.....	33.5	10	6.2	28.8	21.8	——
Bartica, British Guiana.....	32.3	10.2	6.8	42.2	23.2	——
Obidos, Brazil.....	35.5	11	7	49	24.7	——
Santarem, Brazil...	30.8	10.3	6.7	43.2	23.8	——
Pacaya, Peru.....	34.2	10.7	6.8	46	24.8	——
♀						
Canal Zone, Panama.....	38.3	11.7	7.8	53	30	39
La Piedrita, Venezuela.....	41	10.9	6.9	35	26	31
Bartica, British Guiana.....	41.5	11.2	7.4	51.8	28	35.8

Decided abbreviation of the organs of flight, likewise accompanied by very considerable narrowing distad, is shown by material before us of *Parabucrates brevicauda* (Scudder) from the same locality as normal macropterous specimens.

Copiphora cochleata Redtenbacher

1891. *Copiphora cochleata* Redtenbacher, Monogr. der Conoceph., p. 341, pl. 3, fig. 4. [♂, ♀; Chiriqui, Panama.]

Bugaba, Chiriqui, (W. Schaus), 1 ♀.

The extraordinary specialization of the fastigium and dotted tegmina make this one of the most distinctive species of the tropical American Tettigoniidae.

Copiphora rhinoceros Pictet

1888. *C[opiphora] rhinoceros* Pictet, Mém. Soc. Phys. Hist. Nat. Genéve, XXX, No. 6, p. 48, pl. 2, fig. 25. [♀; Central America.]

Bocas del Toro, July 1 to 10, 1908, (Wirt Robinson), 1 ♂.

This handsome insect is apparently the most abundant species of the genus in Costa Rica.

Copiphora brevirostris Stål

1873. *C[opiphora] brevirostris* Stål, Öfv. K. Svenska Vetensk.-Akad. Förh., 1873, No. 4, p. 50. [♀; Cartagena [, Colombia].]

France Field, Canal Zone, July 7, 1920, (M. Hebard; at night, on stem of reed in thicket of reeds growing about fifteen feet high among palms), 1 large juv. ♀.

Gatun, C. Z., July 19 to August 5, 1916, (D. E. Harrower), 3 ♂, 2 ♀.

Barro Colorado Island, C. Z., July 23 to August 20, 1924, (N. Banks), 3 ♂, 1 ♀.

Porto Bello, February 22, 1911, (A. Busck), 1 small juv. ♀; March 19, 1911, (A. Busck), 1 ♀; May 25, 1911, (No. 096931 Biol. Surv. Dept. Agr.; almost entire, from bird stomach), 1 ♂, [U.S.N.M.].

The face varies in individuals of this series from uniform straw color to bright chestnut. The ovipositor shows the greatest length development in the subfamily, being 82.8 to 89 mm. in the present material and 91.2 in an Ecuadorean specimen.

The species is not known from north of the Canal Zone. In South America it has been recorded south to the Rio Pescado, Ecuador.

Lirometopum coronatum Scudder

1875. *Lirometopum coronatum* Scudder, Proc. Boston, Soc. Nat. Hist., XVII, p. 458, pl. on p. 456, figs. 1 and 2. [♀; Greytown, Nicaragua.]

Bugaba, Chiriqui, (W. Schaus), 1 ♀.

The huge flat face is distinctive, the general coloration light green except the clypeus, labrum, mandibles and chitinous portions of the abdominal sternites, which are shining black. The prominences of the head, described as piceous by Scudder, are immaculate in the specimen here recorded as well as in three Costa Rican individuals.

The species has been recorded from Costa Rican localities and "Colombia" the latter very possibly from Panama, as for definite records the above is the southernmost.

SUBRIA Stål

Presence in the collections being studied of a species evidently closely related to *Eriolus* Bolivar, but quite distinct in a number of features, led to a study of the forms referred to the Agraeciinae where confusion with those of the Copiphorinae might have occurred. To our surprise we find that this individual represents *nitida* Stål, genotype of *Subria*, to which genus subsequent authors have referred well marked species of the Agraeciniae, Kirby having placed *nitida* as a synonym of one of these, Walker's *grandis*, described from Demerara.

Thus *Subria*, as properly restricted including only the genotype, is found to belong to the Copiphorinae and nearest *Eriolus* as here restricted, the other species hitherto assigned to *Subria* remaining in the Agraeciinae and belonging to *Erecthis* Bolivar and a related genus or genera, still unnamed.

Compared with the genotype of *Eriolus*, the Cuban *caraibeus* Bolivar, we find *Subria nitida* distinguished by the pronotal disk being moderately but distinctly more produced caudad, so that the humeral sinus of the pronotal lateral lobes is more distinct though not deep; the broad tegminal apices which show rounded truncation and the small inconspicuous flecks in the discoidal field of the tegmina. Should subsequent studies prove these differences insufficient for generic separation, *Eriolus* would fall as a synonym of *Subria*.

The following characters are shared by these genera. Fastigium tapering, fully as wide as first antennal joint proximad, its ventral surface lying in the flattened facial plane; apex blunt (or acute in species of *Eriolus*). Face and genae smooth or nearly so. Prosternum unarmed. Pronotum with principal sulcus weak, dorsum rounding almost evenly into lateral lobes (but with shoulders indicated caudad in *Subria*); lateral lobes much deeper at ventro-caudal angle (situated meso-caudad) than elsewhere. Tegmina fully developed (varying to slightly reduced in *Eriolus*). General coloration green[70] (immaculate in *Eriolus*).

[70] In such very delicate material decay is very likely to occur. Like Stål's specimen of *nitida*, ours is discolored, yellowish, but still shows traces of light green, undoubtedly the general coloration of the insect in life.

Subria nitida Stål

1874. *Subria nitida* Stål, Recensio Orth., II, p. 114. [♀; Remedios, [Antioquia,] Colombia.]

Barro Colorado Island, Canal Zone, July 18, 1924, (N. Banks), 1 ♀.

The dark brown maculations in the discoidal field of the tegmina are few and inconspicuous in this specimen. The pronotal disk shows a diffused line of brown on each side caudad.

Length of body 22.3, length of pronotum 7.8, caudal width of pronotal disk 3.2, length of tegmen 34.1, width of tegmen 6, length of caudal femur 20.3, width of caudal femur 4.3, length of ovipositor 14.8, median width of ovipositor 2.2 mm.

Specimens of both sexes from Aracataca, Colombia, hitherto unstudied, are identical in all important features with this individual.

ERIOLOIDES new genus

The genotype is *Eriolus consobrinus* Saussure and Pictet, other species previously assigned to *Eriolus* but now referred here are *spiniger* (Redtenbacher), *mexicanum* (Saussure) and *frater* (Redtenbacher), while *longipennis* Redtenbacher and *jamaicensis* Bruner[71] may also be congeneric, though the deplanate dorsal surface of the fastigium and disk of pronotum defined from the lateral lobes in those two species show them probably best referable to another, still undescribed, genus.

Compared with the genotype of *Eriolus* Bolivar, the Cuban *caraibeus*[72] Bolivar, we find *Eriloides* to be distinguished by the broad ovipositor, which has the dorsal valves sharply oblique-truncate apically and their dorsal margin distinctly though broadly convex mesad. In both genera the fastigium is convex dorsad (except for the two species mentioned above), the apex acute in many forms but blunt in a few. Other characters of importance which they share are the following. Face and genae smooth or nearly so. Prosternum unarmed. Pronotum with principal sulcus weak, dorsum rounding into lateral lobes with little or no definition, lateral lobes much deeper at ventro-caudal angle (situated meso-caudad) than elsewhere. Tegmina fully developed to slightly reduced, their apices rounded. General coloration green.

[71] Material of all of these species is in the Philadelphia collections except *spiniger* and *frater*.

[72] A female of this species is in the Academy collection.

These genera show a distinct tendency toward certain genera of the Agraeciinae.

Erioloides consobrinum (Saussure and Pictet)

1898. *Eriolus consobrinus* Saussure and Pictet, Biol. Cent.-Amer., Orth., I, p. 384, pl. 19, figs. 6 and 7. [♂; Lanquin and Capetillo, Guatemala; Volcano of Chiriqui, Panama.]

Obispo Station, Canal Zone, 1 ♀, [Mus. Comp. Zool.].
Paraiso, C. Z., February 28, 1911, (E. A. Schwarz), 1 juv. ♀.

Two Costa Rican females, apparently representing this species, are considerably larger than the female here recorded, which measures; length of body 18.4, length of pronotum 5.7, length of tegmen 28.2, length of ovipositor 8.8, median width of ovipositor 2.2 mm.

AGRAECIINAE

Eppia truncatipennis Stål

1875. *E[ppia] truncatipennis* Stål, Bih. K. Svenska Vet.-Akad. Handl., III, No. 14, p. 42. [♀; Chiriqui [, Panama].]

Gatun, Canal Zone, July 17 to 31, 1916, (D. E. Harrower), 1 ♀, 1 juv. ♂, 3 juv. ♀, (female brown, immatures green).

Though the broad fastigium violates the feature usually given as most important to separate the Agraeciinae from the Copiphorinae, it is clear that *Eppia* Stål is a member of a series of related genera which are best referred to this subfamily. These genera are; *Uchuca* Giglio-Tos, *Dectinomima* Caudell, *Eppia* Stål and *Sphyrometopa* Carl, the latter being the most aberrant in having the fastigium even wider than in *Eppia*.

The species has been reported from Retaleuleu, Guatemala, and we have material yet unreported from Costa Rica and northern Colombia.

Dectinomima jenningsi Caudell

1910. [*Dectinomima*] *jenningsi* Caudell, Proc. Ent. Soc. Washington, XII, p. 96. [♀; upper Pequini River, Panama.]

The type, secured in March, 1909, by A. H. Jennings, has been examined in the United States National Museum. The species has been figured in color,[73] Karny in 1912 placing the related genera, here discussed under *Eppia*, part in the Agraeciinae, part in the Copiphorinae.

[73] Genera Insectorum, Fasc. 139, Orth., Locustidae, Copiphorinae, pl. 1, fig. 10, (1912).

CONOCEPHALINAE

Conocephalus cinereus Thunberg

1815. *C[onocephalus] cinereus* Thunberg, Mém. Acad. Imp. Sci. St. Pétersbourg, v, p. 273. [Jamaica.]

France Field, Canal Zone, July 7, 1920, (M. Hebard; in coarse, tall, saw-edged grass about two feet high), 1 ♂, (macropterous).

Gatun, C. Z., September 1 to 7, 1922, (D. E. Harrower), 1 ♂, (brachypterous).

Tabernilla, C. Z., May 8 to July 20, 1907, (A. H. Jennings), 2 ♂, 3 ♀, (all macropterous).

Plantation "Borracho," C. Z., July 10, 1918, (Dietz and Zetek; in grass under papaya trees), 1 ♀, (nearly semi-brachypterous).

Ancon, C. Z., November 12, 1913, (M. Hebard; in open marshy grassland), 6 ♂, 6 ♀, (pair nearly semi-brachypterous, others macropterous).

Panama City, (J. Zetek), 1 ♂, (macropterous).

This plain species prefers an open habitat. It is known from the Bahamas and Vera Cruz, Mexico, to French Guiana and Peru. It has been recorded from Punta di Sabana, Darien, Panama, by Griffini, as Xiphidium fasciatum and variety saltator.

Conocephalus angustifrons (Redtenbacher)

1891. *Xiphidium angustifrons* Redtenbacher, Monogr. der Conoceph., p. 524. [♂, ♀; Bogotá and Tolima, Colombia.]

Gatun, Canal Zone, July 17 to 23, 1916, (D. E. Harrower), 3 ♂, 8 ♀, 2 juv. ♂, 2 juv. ♀, (two males and three females brachypterous, others macropterous).

Gulf of San Blas, July, 1922, (D. E. Harrower), 1 ♂, 1 ♀, (brachypterous).

The rich green on the sides and dark tegmina which become pale toward the humeral vein make this, though not of the very brilliantly colored category, the handsomest of the Panamanian species of the genus.

It has been recorded from Colon and Punta di Sabana, Darien, by Griffini. Its distribution extends from Costa Rica to Colombia.

Conocephalus saltator (Saussure)

1859. *X[iphidium] saltator* Saussure, Rev. et Mag. de Zool., (2), XI, p. 208. [♀, Guiana.]

France Field, Canal Zone, July 7, 1920, (M. Hebard; common in a coarse saw-edged grass growing about two feet high), 1 ♂, 2 ♀, (pair brachypterous, one female macropterous).

Gatun, C. Z., July 17 to August 22, 1916, (D. E. Harrower), 6 ♂, 14 ♀, (two macropterous, others brachypterous).

Gamboa, C. Z., July 9, 1924, (N. Banks), 1 ♀, (brachypterous).

Frijoles, C. Z., July 10, 1924, (N. Banks), 1 ♂, 1 ♀, (macropterous).

Tabernilla, C. Z., June 18 and July 24, 1907, (A. H. Jennings), 1 ♂, 1 ♀, (quite brachypterous).

Ft. Davis, C. Z., July 5, 1924, (N. Banks), 1 ♂, (brachypterous).

Juan Mina Plantation, C. Z., July 13, 1918, (Dietz and Zetek; swept from grass and cow peas), 1 ♂, (macropterous).

Ancon, C. Z., February 11, 1920, (J. Zetek), 1 ♂, (brachypterous); August 6 and 8, 1924, (N. Banks), 2 ♂, (one brachypterous, one macropterous).

Panama City, (J. Zetek), 5 ♀, (brachypterous).

Gulf of San Blas, July, 1922, (D. E. Harrower), 1 ♂, 1 juv. ♀, (male brachypterous).

This ubiquitous species has been recorded from Ancon, Old Panama, Zone limit five miles west of Empire and Culebra, and as the synonymous *propinquum* from Colon and Tintin, Darien. Its distribution extends from Nicaragua and Montserrat in the West Indies, southward to Paraguay.

LISTROSCELINAE

Phlugis teres (DeGeer)

1773. *Locusta teres* DeGeer, Mem. Hist. Ins., III, p. 458, pl. 40, fig. 5. [♀, Surinam.]

France Field, Canal Zone, July 7, 1920, (M. Hebard; common in a coarse saw-edged grass growing two feet high), 9 ♂, 3 ♀; August 18, 1920, (M. Hebard; few, in same spot), 1 ♀.

Gamboa, C. Z., July 9, 1924, (N. Banks), 1 ♀.

Guamina, Rio Chagres, March 4, 1922, (G. H. H. Tate), 1 ♂, 2 ♀.

Limon Plantation, Rio Chagres, July 14, 1918, (Dietz and Zetek; sweeping, in corn field,) 1 ♂, 1 ♀.

Gulf of San Blas, July, 1922, (D. E. Harrower), 1 ♂.

We noted that these insects fly farther than *Conocephalus saltator*, but in other respects are quite similar in their actions.

This minute green, immaculate insect superficially closely resembles *P. chrysopa* Bolivar, but is readily distinguished by having four instead of five pairs of elongate spines on the cephalic tibiae, the male ultimate tergite which lacks elongate decurved fingers and the male subgenital plate which differs in shape with distal thickening more elongate and gradual.

Under this species we placed *P. mantispa* (Bolivar) in 1924. Redtenbacher located as this species, we are satisfied erroneously, a larger South American species with annulate antennae and five pairs of spines on the cephalic tibiae, though at the same time quoting the type measurements, and was followed in this error by Saussure and Pictet and by Karny. The previous Panamanian record of *teres* by Griffini followed that course, being based on a specimen of the larger Panamanian species with annulate antennae, here described as *P. poecila*. All previous records of *mantispa*, however, appear to be referable to the present species, whose distribution is found to extend from Tampico, Mexico, to Duran, Ecuador and the Argentinian Chaco.

Phlugis simplex new species (Pl. XXI, figs. 1 and 2.)

This small immaculate species belongs to the Chrysopa Group and may be distinguished from *P. chrysopa* Bolivar by the male genitalia; the ultimate tergite being produced between the cerci in two very small, adjacent, horizontal processes and the subgenital plate less inflated distad, that portion in lateral aspect broadly rounded instead of sharply angulate distad. The size appears to be slightly smaller and the eyes even more prominent, features which, though unsatisfactory, alone appear to be of any value in separating females.

Type: ♂; Gold Hill, Canal Zone, Panama. November 14, 1913. (M. Hebard.) [Hebard Collection, Type No. 1067.]

Size small for the genus; form slender, normal. Pronotum with cephalic margin not reflexed; metazona decidedly produced and weakly ascending caudad, weakly cucullate above the tegminal bases, the caudal margin evenly convex. Tegmina pellucid, slightly surpassing the apices of the caudal femora, with about fifteen transverse veins in marginal field. Wings pellucid, surpassing the tegmina by a considerable distance. Cephalic femora armed ventrad with three cephalic and four caudal elongate spines; caudal femora with a few very irregular placed spinulae distad. Cephalic tibiae straight (or very slightly

curved), armed ventrad on each side with five very elongate curved spines and a minute distal spur, median tibiae armed with two ventro-external spines. Ultimate tergite produced between cerci in two very small straight horizontal adjacent finger-like processes, the dorsal surface of each concave, the rounded apices not reaching the median portion of the elongate cylindrical cerci. Subgenital plate produced and trough-like to cercal apices, there cleft and enlarged vertically so that two adjacent plates are formed, in lateral aspect the production forming this large apical portion is seen to be in a ventro-caudal direction, the ventral and distal margin rounded, this more decided ventro-caudad but showing no angulation there whatever.

Allotype: ♀; Zone limit five miles west of Empire, Canal Zone, Panama. November 14, 1913. (M. Hebard.) [Hebard Collection.]

Agrees with male in ambisexual characters, size very slightly larger. Ovipositor with elongate swollen base, dostal portion curving rather decidedly dorsad to the acute apex.

No satisfactory characters can be found to separate this sex of the species of this group.

General coloration very light green, entirely immaculate. Eyes brown. Wings hyaline, iridescent.

Length of body ♂ 10.7, ♀ 12; length of pronotum ♂ 3.7, ♀ 3.2; length of tegmen ♂ 11.7, ♀ 13; length of exposed portion of wing ♂ 4.2, ♀ 4.2; length of cephalic femur ♂ 3.3, ♀ 3.3; length of caudal femur ♂ 9, ♀ 9.3; length of ovipositor 4.2 mm.

In addition to the described pair we have a male paratype, taken at Corozal, Canal Zone, Panama, on November 17, 1913 by the author and another female from La Sabana, Panama, secured July 7, 1924, by N. Banks.

Phylugis chrysopa Bolivar (Pl. XXI, fig. 3.)

1888. *Ph*[*lugis*] *chrysopa* Bolivar, Mém. Soc. Zool. France, I, p. 152. [♂, Cuba.]

1898. *Thysdrus mexicanus* Saussure and Pictet, Biol. Cent.-Amer., Orth., p. 402. [♂, ♀; Chilpancingo, Atoyac, Teapa, Mexico; San Geronimo and Zapote, Guatemala; Bugaba, Panama.]

1898. *Thysdrus infirmus* Saussure and Pictet, Biol. Cent.-Amer., Orth., I. pl. 402, pl. 19, figs. 30 to 32. [♀; San Geronimo, Guatemala[74]; Cayenne, [French] Guiana.]

[74] Here selected as type locality for *infirmus*.

Saussure and Pictet's *mexicanus* is clearly the same as *chrysopa*, the confusion apparently caused by misconception of the distinguishing genitalic features of the male, as found in the literature for *virens* of authors (= *chrysopa*). Females having the ovipositor malformed led to the description of *infirmus*, the Nicaraguan individual probably representing *chrysopa*, the most abundant species in that region. We have before us a female of *P. teres* (DeGeer) from the Rio Napo, Loreto, Peru, having a similarly malformed ovipositor.

Rehn placed his genus *Alogopteron* as a synonym of *Phlugis* and his species *carribbeum* under *virens* in 1905, this synonymy not being noted by Kirby in his Catalogue the following year. The type, a female from Turrialba, Costa Rica, probably represents *chrysopa*, as the species is also the most abundant in that country.

After examination of the literature covering *Conocephalus virens* Thunberg, we find that the type, a female from an unknown locality, belongs to the Chrysopa Group which includes the present and a number of other species. There is no character described which could place *virens* as any one of these, nor can they be determined from females unless secured with males. As a result, we feel fully justified in placing Thunberg's name as unidentifyable and using *chrysopa* for the species here considered, Cuban material before us showing this association to be correct.

France Field, Canal Zone, July 7, 1920, (M. Hebard; in a coarse saw-edged grass growing two feet high), 1 juv.; August 18, 1920, (M. Hebard; same, with *P. teres* and *P. poecila* here described), 3 ♂, 1 ♀.

Ancon, C. Z., February 11, 1920, (J. Zetek), 1 ♂; August 2, 1924, (N. Banks), 1 ♂; November 16, 1913, (M. Hebard), 1 ♀.

Pinogana, Darien, December, 1910, (Muñoz), 1 ♂.

Under *teres* a comparison with the present species has been made.

We are obliged, due to the frequent placing in the literature as *virens*, of females of probably a number of allied South American species, to define the range of *chrysopa*, as known from males to extend from Cuba and Vera Cruz, Mexico, to Aracataca, Magdalena, Colombia. In large Guianan and Amazonian

collections before us, males of allied species, but not of *chrysopa*, are represented.

Phlugis abnormis (Redtenbacher)

1891. *Thysdrus abnormis* Redtenbacher, Monogr. der Conoceph., p. 538, pl. 4, fig. 95. [♂, Retalulen (= Retahluleu, western Guatemala).]

Porto Bello, February 27 and 28, 1911, (A. Busck), 1 ♂, 2 ♀. Gulf of San Blas, July, 1922, (D. E. Harrower), 1 ♂.

This species is apparently much less abundant than *P. chrysopa* Bolivar, with which it agrees closely except in the very different male genitalia, the ultimate tergite developed into two flattened rounded projections with two very slender decurved processes between and apical thickening of subgenital plate similar but slightly deeper. Females are so similar that association with males from the same locality is the only means we can find to place them.

Phlugis poecila new species (Pl. XXI, figs. 4, 5 and 6.)

1896. *Thysdrus teres* Griffini (not *Locusta teres* DeGeer, 1773), Boll. Mus. Zool. Anat. Comp. Univ. Torino, XI, No. 232, p. 30. [♀, Darien.]

This species is apparently nearest the South American *Thysdrus teres* described by Redtenbacher and Karny (not *teres* of DeGeer), differing in the medio-longitudinal orange band on pronotum and tegmina proximad and in the male genitalia, as shown by comparison with a South American series which we believe represents that unnamed insect.

It, with that species, forms the Poecila Group, distinguished by the relatively large size but slender form, elongate organs of flight, annulate antennae, tegmina with very numerous transverse veins in the marginal field and cephalic tibiae with five pair of spines. The general form of the subgenital plate agrees with that of the species of the Chrysopa Group.

Type: ♂; France Field, Canal Zone, Pamana. July 7, 1920. (M. Hebard.) [Hebard Collection, Type No. 1068.]

Size large for the genus, form very slender. Pronotum with cephalic margin somewhat reflexed; metazona moderately produced and weakly cucullate above the tegminal bases, the caudal margin evenly convex. Tegmina pellucid, slightly surpassing (to falling slightly short of) the apices of the caudal femora, with about twenty-five transverse veins in marginal field. Wings pellucid, surpassing the tegmina by a considerable

distance. Cephalic femora armed ventrad with three cephalic and four caudal, elongate spines; caudal femora with a few, irregularly placed spinulae distad. Cephalic tibiae very weakly curved, armed ventrad on each side with five very elongate curved spines and a minute distal spur; median tibiae armed with two ventro-external spines and (frequently) with two smaller ventro-internal spines. Ultimate tergite cleft medio-longitudinally, produced in two small, flat, elongate-trigonal processes, with plane surfaces slanting ventro-mesad and narrow apices rounded, not extending beyond proximal two-fifths of the elongate, cylindrical, slightly incurved cerci, which have bluntly rounded apices. Subgenital plate produced, trough-like to slightly beyond cercal apices, there cleft and enlarged vertically so that two adjacent plates are formed with external surfaces weakly convex, in lateral aspect the production forming this enlarged apical portion is seen to be mainly dorsad, the ventral margin straight but slightly declivent and forming with the faintly concave distal margin a right angle, the dorsal margin straight, ascendant and then weakly curving into the distal margin.

Allotype: ♀; same data as type but taken August 18, 1920. [Hebard Collection.]

Agrees with male in ambisexual structural features and in all the striking markings. Size somewhat larger, form a little less slender. Ovipositor very similar in general character to that of *P. simplex* here described, but more elongate with proximal portion less decidedly swollen and distal blade not as strongly curved dorsad. Subgenital plate slightly broader than long, lateral margins convergent and weakly convex to the acute apex.

General coloration very light green. Eyes brown. Antennae with two proximal joints of that color, thence very finely annulate with black and white, becoming solidly dark distad. Pronotum with a decided medio-longitudinal strip of zinc orange, this continued on the tegmina as a suffusion of their sutural margins in proximal half. Sides of abdomen amber yellow in best preserved specimens.[75]

The immature condition has the antennae broadly annulate in black and white, the head and pronotum with a medio-longitudinal band of brown, which is indicated on the abdomen by a brownish medio-longitudinal suffusion.

[75] So delicate is the structure of these diminutive insects that decided changes in color are almost certain to occur, if particular care in drying has not been given.

Measurements (in millimeters) of extremes

♂	Length of body	Length of pronotum	Length of tegmen	Length of exposed portion of wing	Length of cephalic femur	Length of caudal femur	Length of ovipositor
France Field, Panama. *Type*..	14.3	3.8	16.3	6.1	4.7	13	——
France Field, Panama. *Paratype*	14.5	3.8	15.2	6.2	4.8	12.8	——
Aracataca, Colombia.....	13.7	4.1	14.8	6.7	5.1	13.3	——
Aracataca, Colombia.....	13	4	14.3	5.8	4.9	12.2	——
♀							
France Field, Panama. *Allotype*	16.5	4	17.5	6.8	5.4	14.2	5.9
France Field, Panama. *Paratype*	16.6	4.1	16.8	5.7	5.2	14.2	5.9

Specimens Examined: 11; 5 males, 4 females and 2 immature individuals.

France Field, Canal Zone, July 7 and August 18, 1920, (M. Hebard; rare in coarse saw-edged grass growing about two feet high, actions like those of *P. teres*) 2 ♂, 3 ♀, *type, allotype, paratypes*, 1 small juv. ♂, 1 large juv. ♀.

Barro Colorado Island, C. Z., July 19, 1924, (N. Banks), 1 ♀, *paratype*.

Limon Plantation, Rio Chagres, July 14, 1918, (Dietz and Zetek; sweeping in corn field), 1 ♂, *paratype*.

Aracataca, Magdalena, Colombia, August 6 and 8, 1920, (M. Hebard; in short guinea grass growing in opening in forest and with hand light on sugar cane at night), 2 ♂.

Phlugis marginatus (Redtenbacher)

1891. *Thysdrus marginatus* Redtenbacher, Monogr. der Conoceph., p. 537. [♀, upper Amazon.]

Gatun, Canal Zone, July 1 to 23, 1916, (D. E. Harrower), 1 ♀.

This specimen agrees fully with the original description. We have also before us a female from Pará, Brazil, recorded by Rehn in 1918, and a previously unrecorded female from Carrillo, Costa Rica, taken July to September, 1903, by C. F. Underwood, belonging to the author. Though these females resemble each other closely, there can be no assurrance that they do not represent one or more closely allied species of a distinctive group tather than true *marginatus*. Males from these regions alone can solve this problem.

The general appearance of these females differs strikingly from that of the other species here treated, this caused mainly by the heavier build, larger eyes and less strongly caudate tegmina and wings.

The Marginatus Group may be characterized by the moderately large size, robust form for the genus, very large eyes, cephalic margin of pronotum not reflexed, cephalic tibiae with five pair of spines, ovipositor with narrower blade and emarginate female subgenital plate. To it probably also belongs the South American *P. caudatus* (Redtenbacher).

Arachnoscelis magnifica new species (Pl. XXI, figs. 8, 9 and 10.)

This insect, of most unusual form and brilliant coloration, is related to the Colombian *A. arachnoides* (Redtenbacher), differing in features of coloration, the decidedly shorter limbs, weaker dorsal armament of the median tibiae and in the male genitalia.

Type: ♂; Gatun, Canal Zone, Panama. July 28 to August 5, 1916. (D. E. Harrower). [Hebard Collection, Type No. 1069.]

Size small for the group, body moderately robust, surface shining, much as in *arachnoides*. Limbs very elongate and slender, but shorter than in that species; caudal femora decidedly enlarged proximad. Head very large in proportion to body bulk, reaching ventrad far below ventral surface of body; fastigium convex between the small protruding eyes, its apex very small and little projecting, surpassed by the small facial fastigium which is delicately lamellate dorsad and there forms a rounded rectangulation; face smooth, cheeks inflated and expanding considerably ventrad in cephalic aspect; jaws heavy, symmetrical. Pronotum convex between the weak median and very deep cephalic and caudal sulci; narrow cephalic margin slightly reflexed, slightly broader caudal margin very strongly reflexed. Tegmina greatly reduced, represented by small rounded tympana which project very briefly beyond the pronotum. Ultimate tergite produced as two convex, decurved fingers which are hollowed ventrad, their internal distal portions produced as a straight tooth embracing the subgenital plate, their distal margins thus very strongly oblique with decided concavity proximo-externally.[76] Very small supra-anal plate rounded trigonal. Cerci apparently absent. Subgenital plate with ventral surface intricately sulcate and nodose, roughly

[76] For *arachnoides*, Redtenbacher and Karny have almost certainly described homologous processes as the cerci.

rectangularly produced with latero-caudal angles rounded, mesad from the caudal margin projects a small neck which spreads and divides into two short, stout, parallel fingers with apices rounded, thus forming a rough Y, the neck ascending, the branches horizontal with dorsal surfaces microscopically denticulate. Ventral femoral margins armed with small, moderately elongate spines; cephalic and median with six to seven, caudal with seven to nine of these. Cephalic tibiae curved, armed ventrad with five pairs of elongate, weakly curved spines and a distal pair of minute spurs; auditory foramina conchate. Median tibiae armed dorsad with a single meso-proximal spine on the caudal margin.

Allotype: ♀; same data as type, but taken July 17 to 23, 1916. [Hebard Collection.]

Agrees closely with male in ambisexual features. Abdomen decidedly more bulky. Face not as strongly expanding ventrad, the jaws not as heavy. Pronotal contour more even, the reflection of the margins much weaker. Tegmina represented by minute, vestigial, lateral pads which scarcely surpass the short mesonotum, their external and distal margins evenly convex, the internal margin straight and oblique. Ovipositor of moderate length, with heavy base tapering more gradually into the weakly recurved blade than in *Phlugis*. Subgenital plate deeply V-emarginate, the lateral portions forming sharply rounded angles of slightly less than ninety degrees.

Head, pronotum and male tegmina amber brown; bases of mandibles internally and ventral margin of pronotal lateral lobes extensively caudad and briefly cephalad suffused with black. Proximal antennal joints amber brown or peacock green, thence becoming light brown and deepening distad, the light brown portion often with widely separated annuli of dark brown. Abdomen raw sienna (a light brownish orange) in male with sides of first two tergites peacock green, marked with black as follows; meso-caudal portion of first tergite, all of median portion of second tergite, broad caudal margins of seventh, eighth and ninth tergites and produced fingers of ultimate tergite. Limbs peacock green with irregular suffusions and dots of black, spines largely brown. Caudal tibiae sometimes antique brown. Female very similar but with sides of abdomen largely peacock green, the pale dorsal area including the third to the sixth tergite paler, buffy yellow.

The color differences in *arachnoides* are shown by Karny's color figure of the type of that species.[77]

The paratypes agree closely with the type and allotype in size: length of body ♂ 14, ♀ 15.5; length of pronotum ♂ 4,

[77] Gen. Ins., Locustidae, Listrosc., Fasc. 131, pl. 3, fig. 1, (1911). The female there shown in fig. 2 very possibly represents a distinct species.

♀ 3.9; greatest width of pronotum (meso-ventral) ♂ 4.3, ♀ 4.6; exposed length of tegmen ♂ 1.1, ♀ .6; length of cephalic femur ♂ 10, ♀ 10; length of cephalic tibia ♂ 12.2; length of caudal femur ♂ 18, ♀ 18.2; length of ovipositor 11.7[78] mm.

In addition to the described pair, a male and three female paratypes, bearing the same data, are in the author's collection.

GRYLLACRINAE

Gryllacris panamensis Kirby

1888. *Gryllacris maculata* Brunner, Monogr. Stenopelmat. und Gryllacr., p. 364. [♀; Chiriqui, Panama; Costa Rica.]

1906. *G[ryllacris] panamenis* Kirby, Syn. Cat. Orth., II, p. 147. (Renamed, as *maculata* was preoccupied.)

Frijoles, Canal Zone, (W. M. Wheeler; from *Cordia geraschanthus* Jacq., a tree of the Ehretia Family), 1 large juv. ♀.

This individual appears to represent the present species, of which a small Costa Rican series of adults is before us. It lacks cephalic and tibial markings. Griffini has recorded *panamensis* from Brazil in 1909.

Gryllacris picta Brunner

1888. *Gryllacris picta* Brunner, Monogr. Stenopelmat. und Gryllacr., p. 363. [♀, Costa Rica.]

Gatun, Canal Zone, July 25, to 31, 1916, (D. E. Harrower), 1 ♀.

This is a large specimen of *picta*. A small Costa Rican series of the species shows that decided size variation occurs.

Hyperbaenus festae Griffini

1896. *H[yperbaenus] festae* Griffini, Boll. Mus. Zool. Anat. Comp. Univ. Torino, XI, No. 232, p. 31. [♂; Punta di Sabana, Darien.]

Gatun, Canal Zone, July 17 to 23, 1916, (D. E. Harrower), 1 ♀.

This female, as well as an Ecuadorean example recorded by us, agrees in full with the female recorded from Ecuador by Giglio-Tos as this species, but later described by Griffini as *Gryllacris giglio-tosi*, except that the cephalic tibiae are armed ventrad with five pairs of long spines, the proximal being very elongate.

The species has also been recorded from the Rio Peripa, Gualaquiza and Chaguarapata, Ecuador.

[78] In the paratypes 10.8, 11.3 and 11.8 mm.

EXPLANATION OF PLATES

Plate XVIII

Fig. 1.—*Vellea cruenta* (Burmeister). Dorsal view of female. San José, Costa Rica. (× 1½)

Fig. 2.—*Harroweria gloriosa* new species. Dorsal view of female. *Type.* Gatun, Canal Zone, Panama. (× 1½)

Plate XIX

Fig. 1.—*Gatunia reducta* new species. Lateral view of male. *Type.* Gatun, Canal Zone, Panama. (× 1½)

Fig. 2.—*Gatunia reducta* new species. Ventral outline of distal portion of male subgenital plate and styles. *Type.* Gatun, Canal Zone, Panama. (Greatly enlarged.)

Fig. 3.—*Gatunia linearis* (Rehn). Ventral outline of distal portion of male subgenital plate and styles. *Type.* Carrillo, Costa Rica. (Same scale as fig. 2.)

Fig. 4.—*Vellea cruenta* (Burmeister). Lateral outline of female ovipositor. San José, Costa Rica. (× 2 +)

Fig. 5.—*Cnemidophyllum eximium* new species. Dorsal view of male stridulating field. *Allotype.* Barro Colorado Island, Canal Zone, Panama. (× 1½)

Fig. 6.—*Cnemidophyllum eximium* new species. Lateral view of female. *Type.* Eden, Pis-Pis District, Nicaragua. (½ natural size.)

Fig. 7.—*Montezumina oblongoculata mesembrina* new subspecies. Lateral outline of male cercus. *Type.* Monte Redondo, Costa Rica. (Greatly enlarged.)

Fig. 8.—*Montezumina oblongoculata mesembrina* new subspecies. Caudal outline of erect distal portion of male cercus. *Type.* Monte Redondo, Costa Rica. (Same scale as fig. 7.)

Fig. 9.—*Montezumina oblongoculata mesembrina* new subspecies. Lateral view of ovipositor. France Field, Canal Zone, Panama. (× 4)

Fig. 10.—*Montezumina oblongoculata oblongoculata* (Brunner). Caudal outline of erect distal portion of male cercus. Orizaba, Vera Cruz, Mexico. (Same scale as fig. 7.)

Fig. 11.—*Montezumina bradleyi* new species. Lateral view of head and pronotum of female. *Type.* Barro Colorado Island, Canal Zone, Panama. (× 4½)

Fig. 12.—*Anaulacomera crassidentata* new species. Dorsal outline of male cercus. *Type.* Panama City, Panama. (Greatly enlarged.)

Fig. 13.—*Anaulacomera crassidentata* new species. Lateral view of ovipositor. *Allotype.* Ancon, Canal Zone, Panama. (× 4)

Fig. 14.—*Anaulacomera spatulata* new species. Dorsal outline of male cercus. *Type.* Porto Bello, Panama. (Greatly enlarged.)

Fig. 15.—*Anaulacomera spatulata* new species. Latero-external view of apex of male cercus. *Type.* Porto Bello, Panama. (Enlargement greater than in fig. 14.)

Fig. 16.—*Anaulacomera spatulata* new species. Lateral view of ovipositor. *Allotype.* Fort Sherman, Canal Zone, Panama. (× 4)

PLATE XX

Fig. 1.—*Anaulacomera uncinata* new species. Dorsal view of male cercus. *Type.* Barro Colorado Island, Canal Zone, Panama. (Same scale as plate XIX, fig. 12.)

Fig. 2.—*Anaulacomera uncinata* new species. Ventral view of male subgenital plate. *Type.* Barro Colorado Island, Canal Zone, Panama. (× 10)

Fig. 3.—*Phylloptera panamae* new species. Dorsal view of pronotum and stridulating field of male tegmina. *Type.* Rio Trinidad, Panama. (× 2)

Fig. 4.—*Phylloptera panamae* new species. Lateral view of male tegmen, to show the position of the oblique bands. *Type.* Rio Trinidad, Panama. (Natural size.)

Fig. 5.—*Lamprophyllum bugabae* new species. Lateral view of female tegmen, showing only principal veins. *Type.* Bugaba, Chiriqui, Panama. (Natural size.)

Fig. 6.—*Balboa tibialis* (Brunner). Lateral view of male. Eden, Pis-Pis District, Nicaragua. (Natural size.)

Fig. 7.—*Idiarthron major* new species. Dorsal view of male ultimate tergite, supra-anal plate and cerci. *Type.* Fort Davis, Canal Zone, Panama. (× 4)

Fig. 8.—*Bliastes banksi* new species. Dorsal view of male ultimate tergite, supra-anal plate and cerci. *Type.* Barro Colorado, Island Canal Zone, Panama. (× 6)

Fig. 9.—*Bliastes bradleyi* new species. Ventral view of female subgenital plate. *Type.* Barro Colorado Island, Canal Zone, Panama. (× 10)

Fig. 10.—*Cocconotus wheeleri* new species. Dorsal view of male ultimate tergite. *Type.* Ancon, Canal Zone, Panama. (Greatly enlarged.)

Fig. 11.—*Cocconotus wheeleri* new species. Lateral view of male cercus. *Type.* Ancon, Canal Zone, Panama. (Greatly enlarged.)

Fig. 12.—*Goethalsiella tridens* new species. Dorsal view of male cercus. *Type.* Barro Colorado Island, Canal Zone, Panama. (Greatly enlarged.)

Fig. 13.—*Scopiorus fragilis* new species. Dorsal view of male ultimate tergite. *Paratype.* Fort Davis, Canal Zone, Panama. (Greatly enlarged.)

Fig. 14.—*Scopiorus fragilis* new species. Ventral view of male subgenital plate. *Paratype.* Fort Davis, Canal Zone, Panama. (Same scale as fig. 13.)

Plate XXI

Fig. 1.—*Phlugis simplex* new species. Dorsal view of male ultimate tergite and cerci. *Type.* Gold Hill, Canal Zone, Panama. (Greatly enlarged.)

Fig. 2.—*Phlugis simplex* new species. Lateral view of male subgenital plate. *Type.* Gold Hill, Canal Zone, Panama. (Greatly enlarged.)

Fig. 3.—*Phlugis chrysopa* Bolivar. Lateral outline of ovipositor. Aracataca, Magdalena, Colombia. (× 6)

Fig. 4.—*Phlugis poecila* new species. Dorsal view of male ultimate tergite and cerci. *Type.* France Field, Canal Zone, Panama. (Same scale as fig. 1.)

Fig. 5.—*Phlugis poecila* new species. Lateral view of male subgenital plate. *Type.* France Field, Canal Zone, Panama. (Same scale as fig. 2.)

Fig. 6.—*Phlugis poecila* new species. Lateral outline of ovipositor. *Allotype.* France Field, Canal Zone, Panama. (× 6)

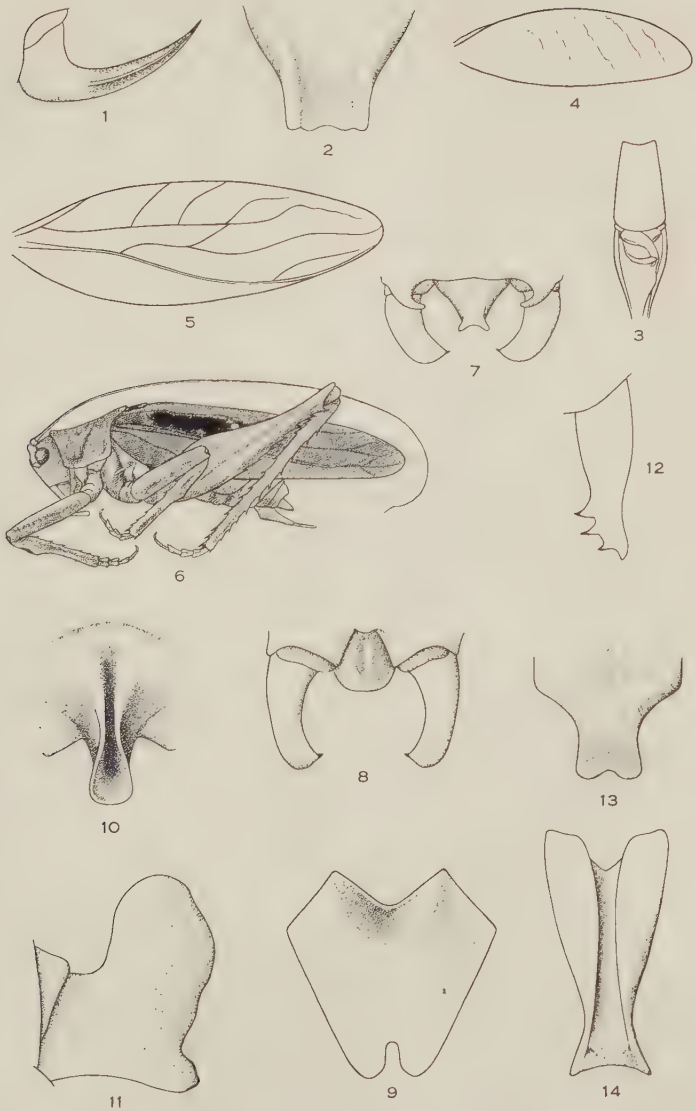
Fig. 7.—*Arachnoscelis magnifica* new species. Dorsal view of male ultimate tergite and supra-anal plate. *Type.* Gatun, Canal Zone, Panama. (Greatly enlarged.)

Fig. 8.—*Arachnoscelis magnifica* new species. Ventral view of male subgenital plate. *Type.* Gatun, Canal Zone, Panama. (Greatly enlarged.)

Fig. 9.—*Arachnoscelis magnifica* new species. Lateral view of female. *Paratype.* Gatun, Canal Zone, Panama. (× 1½)

HEBARD—TETTIGONIIDAE OF PANAMA

HEBARD—TETTIGONIIDAE OF PANAMA



HEBARD—TETTIGONIIDAE OF PANAMA

THE VENATION OF THE LIBELLULINAE (ODONATA)

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I. INTRODUCTION

This group is the big end of the order Odonata. It includes about a fourth of the species. Although these dragonflies are the ones most commonly collected, their systematic study has lagged somewhat behind that of the other groups. Probably this has been due to the confusing variety and abundance of the forms it includes.

There have been four revisions of the genera of Libellulinae with keys. The first, by Brauer, included in his *Verzeichniss der bis jetzt belkannten Neuropteren im Sinne Linne* (1868) enumerated forty genera. The second, by W. F. Kirby, *Revision of the Subfamily Libellulinae*,[1] included eighty-eight genera. The third, by Karsch, *Beitrage zur Kenntniss der Arten und Gattungen der Libellulinen*,[2] following close upon Kirby's revision added some new genera, rearranged them under the four principal groups of Brauer, and briefly indicated relationships within the very large fourth group. The fourth and most important revision is that of Dr. Ris in the descriptive catalog of the de Selys Collection.[3] In this, one hundred and twenty genera are

[1] Trans. Zool. Soc. London, XII, p. 249–348, 1887.
[2] Berl. Ent. Zeitschr., XXXIII, p. 347–392, 1889.
[3] Coll. de Selys, Zool., Fas. 9 to 16, 1909–1916.

recognized. Ris made full use of the wealth of materials in the Baron de Selys collection, and of much besides, and provided illustrations of every one of the then known genera.

This monumental work of Dr. Ris has brought the study of the group to the point where special investigations of particular structures are needed to further clarify relationships. The present paper is an effort to discover what further evidence may be found in the venation. Ris divides the Libellulinae into ten equivalent groups. Within each of these excellent keys are provided; but there is no key to the ten groups, they are not sharply defined, and they are not easy to grasp. All the genera are illustrated by actual photographs of wings, and these, supplemented by the materials in the collection of the senior author, we have studied in the two-fold hope of making the group a little easier of access to the beginner, and of making relationships within it a little more clear. We present first a brief survey of the venation of the subfamily and then a key to the genera.

II. The Libelluline Wing

A typical Libelluline wing is shown in Figure 1. It is chiefly characterized by three things:

1. The triangle of the forewing is transversely elongated.
2. The triangle of the hindwing is elongated in the axis of the wing and is retracted to the level of the arculus.
3. The expanded anal angle of the hind wing is supported by a more or less footshaped anal loop.

All these things have had an evolution within the subfamily and are less developed or not at all developed in the more generalized members of it. The anal margin of the hind wing is never angulated as in the males of Cordulinae. In the wider spaces between the branches of principal veins there are interpolated veins of two sorts; *sectors* that are formed about strong tracheal branches and that curve out toward the wing margin, and *planates* or *supplements*[4] that are independent of the largest

[4] Baron de Selys called these "supplementary sectors." More recent authors, following Needham ('03) have called these "supplements," and have used the abbreviation *suppl* or *spl* for them. We believe it expedient to adopt the more appropriate name *planates* for them as proposed by Needham for the same sort of veins in Myrmeleonidae (in Comstock's *The Wings of Insects* p. 205, 1924) and to use the designation *pl* (which, happily, is but two-fifths of the previous label).

trachea and run more or less squarely across the sectors, more nearly paralleling the wing margin. The most constant of the sectors is the one that springs from M, behind the stigma (designated M_{1a} and called the apical sector); other sectors

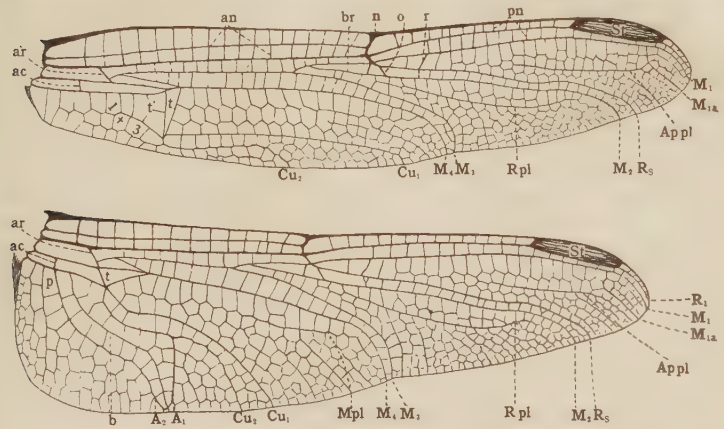


Fig. 1. Wings of *Orthemis ferruginea*, labelled to illustrate Libelluline venation. Principal veins labelled only at the outer wing margin: R_1, radius; R_s, radial sector. M_1, M_2, M_3 and M_4, Cu_1 and Cu_2, the branches of media and cubitus respectively. *St*, stigma; *n*, nodus; *an* and *pn*, ante- and post-nodal cross veins; *br*, bridge; *o*, oblique vein; *r*, reverse vein; M_{1a}, apical sector; *Ap.pl*, apical planate; *R.pl*, radial planate; *M.pl*, median planate; *ar*, arculus; *ac*, anal crossing; *t*, triangle; *t'*, subtriangle; *1 + 3*, row of cells that subtends the subtriangle; *p*, patella; *b*, bisector of the anal loop.

spring to rearward from R_s, M_4, Cu_2 and from all the branches of the anal vein, especially in those wings in which these areas have considerable breadth.

Planates are formed by the straightening out of zig-zag lines of cross-veins. At first they are absent; then they appear as weak or broken lines; then they become straighter and stronger; and finally they become linked up at the ends with the veins in front of them (as if to supplement and strengthen those veins, whence the original name that de Selys proposed for them). Two processes are ever operating in the evolution of the venation; vein shifting and vein differentiation.[5] The

[5] More fully discussed by the senior author in *A Genealogic Study of Dragonfly Venation*, Proc. U. S. Nat. Mus., XXVI, p. 703–764, 1903.

shifting of position in veins and cross-veins is the more easily followed. The primitive course of the veins is in gentle outflowing curves following the course of the tracheae. Cross-veins at first stand erect between the veins.

When the veins become sharply angulated, and the cross-veins meeting the angles become extended lengthwise of the wing, these are departures from the primitive, and are signs of specialization by vein shifting. Vein differentiation, on the other hand, is evidenced in fewer and stronger cross-veins. The primitive dragonfly, we believe, had a copious venation—a dense network of veins, irregular and inconstant. Progress has lain in part in concentrating the vein-building, strength-giving material of the wing where it would do the most good. Vein shifting and vein differentiation may run along together in harmonious accord. The record of progress is confused when they alternately hold sway.

III. A Study of the Wing by Areas

The region of the arculus.—Much use was made by Dr. Ris of the position of the arculus in relation to the first few antenodal cross-veins. In general it may be said that the arculus is farther out in the more primitive members of the family. Its retraction is however more apparent than real, the number of antenodals being reduced. It is beyond the third antenodal only in *Pornothemis* and *Misagria*. It is beyond the second in about a fourth of the group and between the first and second in all the others. It is close to the first in such genera as *Rhyothemis*.

The inclination of the arculus in this subfamily is always outward to meet vein Cu, and the sectors always arise from its lower third; sometimes as in *Macrothemis*, from its extreme lower end. The sectors are never wholly separated at origin; in a small number of genera they are merely apposed at base—not fused. In nearly all they are completely fused for a distance —often a considerable distance in the smaller forms; and this distance is often greater in the hind than in the fore wing.

The degree of basal fusion of the sectors of the arculus we have not used at all in our key because, for many of the genera, we have had to depend upon Dr. Ris' figures; and the extent of this fusion as shown in a photograph is in part determined

by the flatness of the wing before the camera. Fortunately this limitation will not apply to the characters we have used.

The region of the nodus.—The position of the nodus in the length of the wing varies greatly within the subfamily. In such genera as *Nesoxenia*, *Brachygonia* and *Tyriobapta* the distance from the nodus to the outer end of the stigma is eight-tenths of the distance from base to nodus. At the other extreme (in *Hydrobasileus* and others) this distance is three-tenths the distance from base to nodus. In a large majority of genera the nodus is at more than half the distance from the base to the outer end of the stigma.

The number of antenodal and postnodal cross-veins is constant only when they are few, but its range is quite characteristic of genera and species. The last antenodal cross-vein before the nodus is complete to R_1 in more than half the genera. Its abbreviation and restriction to the costal space is a sign of specialization. Its complete suppression occurs rarely, as in *Aethiothemis*. The principal cross-vein between the subnodus and the bridge is directly under the subnodus in about half the subfamily, and in all the remainder (except for aberrancies) it is on the proximal side. Additional cross-veins are subtended by the bridge in many of the more primitive genera.

Passing farther rearward we find in a number of the more primitive genera no development of the radial planate. It is weakly developed and stands opposed to vein M_2 in somewhat more than half the genera. In the more primitive, it tends to be closer to the radial sector than is M_2 and in the more specialized farther away and more strongly bent in opposition thereto; it is therefore concave anteriorly, with ends turning forward and often one or the other or in some cases (*Edonis*) both ends being directly conjoined to vein R_s[6]. In *Eothemis* and some of its allies on the contrary it runs parallel to vein R_s, which it much resembles, quite to the outer margin of the wing.

The two parallel pairs of veins, M_2 and R_s and M_3 and M_4, become strongly hooked at the tips in *Lyriothemis and Zygonyx*, and in addition to this they become abruptly approximated at

[6] Tillyard calls this vein median sector (Ms), because he finds that in some Odonata the trachea which precedes it springs from the median tracheal stem. This is, of course, no new discovery.

the beginning of the apical bend in *Tramea*, *Tauriphila* and *Camacinia*. At this point in *Pantala* vein R_s seems to run into vein M_2. Before the inner end of the radial planate, in the space between veins M_1 and M_2, one of the cross-veins (usually the second), called the reverse vein, becomes aslant in opposition to the oblique vein; the three slanting veins (oblique vein, reverse vein, and inner end of radial planate) thus form a tri-radiate brace for this portion of the wing.

The region of the stigma.—The stigma is a weighted and heavily chitinized portion of the wing developed at the point of heaviest impact against the air. It is longest and has contact with the largest number of cross-veins in such forms as *Diastatops* (Fig. 2); it is shortest in such forms as *Nannophya*. The primitive stigma appears to have been rather elongate, with parallel ends. It is so still in the majority of genera. It becomes shortened in the more specialized; and in a few of the swiftest fliers (those that have wings that are pointed at the apex and most broadly expanded to rearward) it becomes trapezoidal, the outer end strongly oblique.

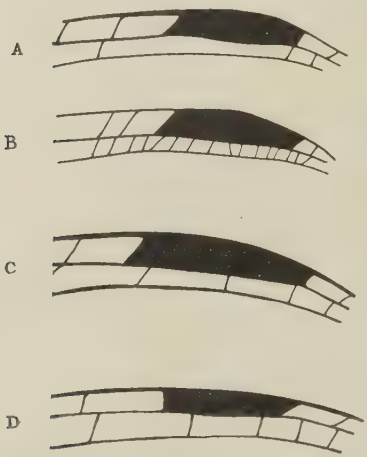


Fig. 2. Forms of stigma. (A) *Pachydiplax*, (B) *Diastatops*, (C) *Pseudoleon*, (D) *Tramea*.

The adjacent supporting cross-veins in the space R_1 become strongly oblique in *Pseudoleon*, *Perithemis* and others, though there is never a single one set against the innermost angle of the stigma to form a distinct "brace vein" as in other families of Odonata. There is a marked clearing out of cross-veins from this area (accompanied as usual by a strengthening of those that remain) just before the stigma in *Pachydiplax*.

An apical sector springs from M_1 behind the stigma, and, turning outward, runs to the apical wing margin. In about a dozen genera this sector originates before the stigma, notably

far forward in *Uracis;* in more than half the genera it takes origin below the basal third of the stigma, in a lesser number under the middle third, and, in a few genera under the apical third. This sector varies in strength as well as position being sometimes in part lost in a zig-zagging course among the cross-veins.

Posterior to the sector, and separated from its straighter portion usually by a single row of cells, is the apical planate. This is less well developed than the radial and medial planates. It is absent from a very large number of the more primitive genera, weak and angulate in perhaps as many more, and becomes straight in about half. In two genera, *Rhyothemis* and *Celithemis*, it is separated from the apical sector by more than one row of cells. In *Tramea*, *Tauriphila* and *Miathyria* the highly developed planate tends to run into the apical sector and then the cells that stand before it become elongated transversely to the axis of the wing. In *Orthemis*, also, there is a parallel elongation of the cells in this region but they are smaller, more numerous, and still in two rows, only those of the anterior being elongated. Big cells in this region are correlated with a remote origin of the apical sector.

The area of the triangles.—The "cardinal cell" of the dragonfly wing is the name given to the discal triangle by some of the older authors; and it is a feature of cardinal importance in all dragonflies, and in none more than in this subfamily. The senior author has given an account of its evolution from an ordinary rectangular cell[7] which need not be repeated except as we find it repeated in the series of wings here studied. Supertriangle, triangle and subtriangle are still four-sided cells in a number of the more primitive genera. Specialization in these parts has gone on mainly by shifts of position. A double reverse bend in the cubital vein, and a slant of the cross-veins at the two angles will account for most of the differences.

In the fore wing the last cubito-anal cross-vein is slanted outwards gradually until it meets the inner angle of the triangle, as shown in a series of genera (Fig. 3). Soon it comes to lie in a line with the basal portion of the anal vein of which it then

[7] A Genealogical Study of Dragonfly Venation, Proc. U. S. Nat. Mus., XXVI, p. 717, 1903.

appears as a continuation. The true course of the anal vein then becomes obscured. Likewise, the cross-vein that extends forward from the bend of the cubital vein, dividing super-triangle from triangle, is slanted outward until it comes to lie

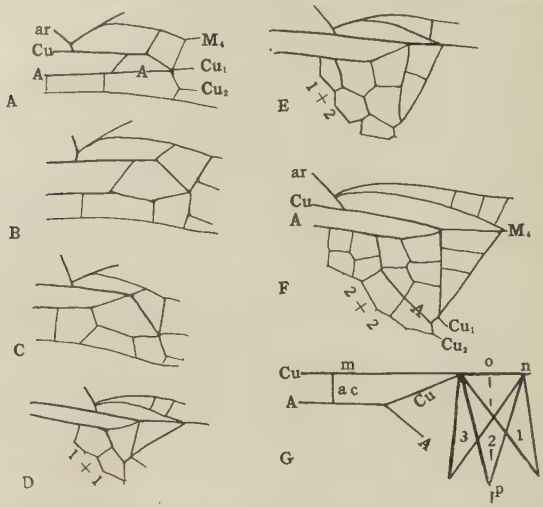


Fig. 3. The triangle of the fore wing. (A) *Bironides*, (B) *Archaeophlebia*, (C) *Oda*, (D) *Perithemis*, (E) *Erythemis*, (F) *Celithemis* (G) Diagram of direction of point of triangle: (1) points out; (2) perpendicular (bisector *o*, *p*, to base line *m*, *n*,); (3) points in.

in the axis of the wing and to appear as the continuation of that vein.[8]

According to the degree of angulation at the first bend of the cubital vein, the acute hind angle of the narrowing triangle of the fore wing points out or in. It is most strongly directed outward in *Uracis* and inward in *Perithemis*. The triangle becomes elongated to rearward and the number of cell rows beyond it increased from one to two, three, or more; two and three being the number most commonly found. Correspondingly, the ratio of length to width, which is as 1 : 1 in the more primitive genera, becomes as 1 : 2 in approximately half of the genera, 1 : 3 in

[8] All of which quite contradicts Tillyard's notion that *Heterophlebia*, with its five-sided triangle, represents the primitive condition (British Liassic Dragonflies, p. 26, 1925). That, however, appears to be based wholly on the untenable assumption that because a form is an ancient fossil it is therefore primitive.

many others, and 1 : 4 or even more in a few. The number of cross-veins in the triangle of the fore wing is in a measure correlated with its transverse elongation. None are present in the more primitive genera; one is present in perhaps half of the genera; two or more are present in comparatively few, those usually containing species of large stature.

Correspondingly, the subtriangle of the fore wing is undivided in many of the more primitive genera, and in a few that are rather highly specialized but have reduced venation. When cross-veins are present they usually are so arranged as to divide it into three cells corresponding, more or less closely, to its three angles. In transitional forms a single cross-vein divides it into two cells, and in some forms with copious venation many cross-veins are present. Early in the series there is evolved a subtending row of cells of definite number and position. A single cell next the anal vein is set apart from those below it so the cells of this row may easily be recorded numerically as 1 + 1, 1 + 2, 1 + 3, etc. The normal number, the number most characteristic of by far the greater part of the group, is 1 + 2.

The triangle of the hind wing always differs in shape from that of the fore wing. It is much less frequently four-sided and it tends from the beginning to be elongated in the axis of the wing with an acute angle pointing outward. It tends also to be retracted in position to the level of the arculus. This is well illustrated by the genera shown in Figure 4. Cross-veins are present much less frequently than in the fore wing triangle. As for the size of the triangles, that of the fore wing is usually larger in area, but it is smaller in a considerable number of rather primitive genera.

In both wings the cubital vein forks at the hind angle of the triangle. When Cu_2 holds to this position vein Cu_1 may migrate up the outside of the triangle as shown for *Mesothemis* in Figure 1. This occurs more frequently in the hind wing, rather rarely in the fore wing. More commonly in the fore wing vein Cu_1 holds to the apical angle of the triangle and vein Cu_2 at its base is shifted downward upon the apex of the anal vein.

The space beyond the triangles, between the branches of the median and cubital veins, expands broadly in the hind wing;

in the fore wing it extends more or less parallel to the margin in most genera, though it widens somewhat in the more primitive, and in a few, such as *Sympetrum* and *Pachydiplax*, it narrows to the outer margin. A trigonal planate is developed only in the hind wing of the giant skimmer *Camacinia*. There is no true subtriangle in the hind wing, and the anal vein is never deflected out of its true course to the hind angle of the triangle. It is not vein shifting but vein reduction that marks the progress in this space. The several cubito-anal cross-veins that are found in most of the generalized forms all disappear save one—the anal crossing—in the majority and in all the more specialized forms.

The area of the anal loop.—The broadly expanded hind angle of the hind wing is supported by branches of the anal vein, which in this subfamily are longer than in the others and tend to form between the first and second an anal loop of unique design. At first it is wanting; then it is of compact form about as long as wide; then it extends to rearward as a double row of cells, each row at first two, then three, then four or more cells long. Then at the distal end, beyond the double flexure, it

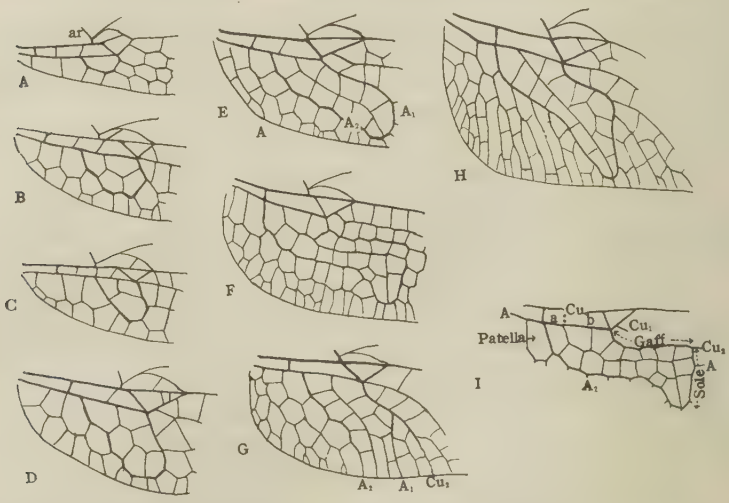


Fig. 4. Forms of Anal loop. (A) *Hypothemis*, (B) *Tetrathemis* (C) *Tetrathemis* (D) *Neodythemis*, (E) *Cannaphila*, (F) *Huonia*, (G) *Nannothemis*, (H) *Perithemis*, (I) Diagram of anal loop with parts named.

developes a "toe" and becomes distinctly footshaped, as it is in by far the greater part of the group. In fact, a footshaped anal loop is quite a distinctive characteristic of the venation of this subfamily.

In figure 4 I is shown such an anal loop. The parts are named chiefly from their resemblance in outline to a foot; heel, toe, knee, instep, etc. There are two parts that are otherwise named; the *bisector* (the midrib of Tillyard) which forms the dividing line between the two principal cell rows and stands midway between the first and second anal vein, and the *gaff*[9] which is a compound of vein Cu_2 and A_1 from the point where they come together at the hind angle of the triangle to the point where they separate at the heel. The gaff begins as a short straight strut extending rearward from the hind angle of the triangle continuing the line of its inner or proximal side. At its outer end its component veins Cu_2 and A_1 separate at a wide angle. As the anal loop elongates the gaff lengthens and takes on a sigmoid curvature. Its distal end swings outward coming more nearly into line with the tip of Cu_2, while A_1 extends rearward to the toe, forming the sole of the footshaped loop. The bisector varies much in the extent of its double angulation, being almost straight in such forms as *Perithemis* and bent nearly at a right angle in *Huonia*.

A short anal loop of four cells occurs in only a few of the more primitive genera, and a loop of two rows of three cells each occurs in about as many more. Then it progressively extends to a blunt outer end as shown in figure 4E; then the toe grows out obliquely to rearward and the footshaped form is established. The toe, as measured along the sole, remains shorter than the gaff in the great majority of cases, is equal to it in length in perhaps a score of genera, and in about half a dozen becomes longer than the gaff. Sectors spring from the sole and from the proximal side of A_2 in a number of genera that have copious venation, such as *Rhyothemis*. The widening of the loop at the level of the heel frequently leads to the interpolation of additional cells, either in the angle of the heel point or at the pivotal point of the ankle; and when extensively widened at the heel a spur

[9] We borrow another not inappropriate nautical term for this compound structure, for which there is need of a convenient designation.

vein is present, developed by a straightening out of cross veins in a transverse line, in a manner similar to that of a planate.

Correlated with the loss of cubito-anal cross-veins that leaves the anal crossing the sole transverse support between Cu and A, there is a progressive migration of the base of vein A_2 (followed by the bisector) toward that support. The relation between the two spaces lettered *a* and *b* in our figure is thus altered. These spaces are approximately equal in the more primitive genera; they become as 1 : 2 in perhaps half; and as 1 : 3 or more in many of the more highly specialized forms.

The loop remains incomplete at its apex (Fig. 4G) in a number of genera, vein A_1 and A_2 not being connected apically. In *Brachygonia* occurs a very anomalous condition in which the gaff and bisector are well developed while A_2 is lost. In a few genera such as *Thermothemis* and *Zyxomma*, in which an anal loop is strongly developed, vein A_2 does not join A_1 apically but has the aspect of being secondarily lost.

Proceeding now toward the wing base there remain two additional descending branches of the anal vein standing between three rows of cells that successively diminish in both length and area basalward. The first row between vein A_2 and A_3 begins with one, two or three large cells that are often well marked off by form and relation from those that follow. This area, lying upon the knee, may be conveniently designated as the *patella*. Along the inner side of vein A_2 there is sometimes differentiated a beautifully regular row of border cells. In *Philonomon* there are three cell rows between vein A_3 and the hind margin; and in the middle row the cells are much longer than in the other two.

IV. Sex Differences

A few rather striking differences in venation in the two sexes of the same species have been pointed out. Kirby noted that the subtriangle of the fore wing in *Perithemis bella* is one-celled in the female and two-celled in the male. Ris figures wings of the two sexes of *Macrothemis delia*[10] showing in the space beyond the triangle in the fore wing two cell rows in the female and but one in the male. These wings show a difference that is not unknown elsewhere: the anal loop is longer, more extended and

[10] Coll. de Selys p. 1215.

with a longer toe in the female, corresponding to her broader wings that have a heavier body to support. Ris' figure of *Hadrothemis camarensis*[11] show a further difference in the wings of the sexes in that the sole line of the anal loop points slightly inward in the male and slightly outward in the female.

V. Signs of Specialization

Our rearrangement of the genera of the Libellulinae is based on the following assumptions as to what is primitive and what is secondary in their venation; that progress has been made:

1. From fore and hind wings that were equal and similar in form, to those unequal and dissimilar.

2. From veins laid down in gently out flowing curves, following the course of their antecedent trachea, to those having sharp-angled bends, as at arculus, triangle, and elsewhere.

3. From triangles in both wings similar and weakly differentiated from ordinary rectangular cells, and similarly placed, to true triangles, well differentiated, that of the fore wing transversely elongated, that of the hind wing retracted to the arculus.

4. From cross veins placed crosswise, to cross veins placed lengthwise of the wing, as at triangle and subtriangle of the fore wing.

5. From indefinite zig-zag lines of cell borders, to strong and definite planates.

6. From indefinite cross veins in the fork of veins M_1 and M_2, to a condition wherein one has emerged as a distinct reverse vein.

7. From a small anal area in the hind wing with no definite supports, to a broad anal area supported by a distinct foot-shaped anal loop.

8. From numerous antenodal cross veins with the arculus placed beyond two or three of them, to fewer antenodals with the arculus before the second, and the last antenodal before the nodus discontinuous.

9. From numerous postnodals, more or less equally spaced, to fewer in the second series with large vacancies at its ends.

10. From a more or less uniform meshwork of cells in the

[11] Coll. de Selys, p. 170.

open areas between veins, to localized groups of larger and smaller and always fewer cells.

VI. A Venational Key to the Genera

The foregoing assumptions as to the order of evolution within the group have been in mind while constructing the following key. Yet, we have at once to confess that, like Ris, we have been unable to find any single character on which to base a natural first cleavage of the group. So, at last we have merely tried to base the earlier divisions of the key on those characters that seem to us most important. In order to make determination easier we have given choice of a single pair of characters wherever at all possible; and as a corrective for all cases in which the key may lead the user astray, we add a table giving fifteen of the most important venational characters of each genus. The table will confirm or confute determinations made by means of the key. The full face numbers in the left hand column are the consecutive numbers of Ris' Monograph (see lists at end of this paper, pp. 187 to 190). The light faced numbers, 1, 2, and 3, in the following columns represent the conditions shown by the "short hand" characters similarly numbered in the column headings, and explained on the page facing the genealogic tree.

The genera included in the key are those recognized by Ris, and those alone. The characters stated in the key are those of the type species. In polymorphic genera there are species that will not in all characters conform. The more important of such genera are marked with an asterisk (*) in the key.

1. (56) Fore wing: triangle pointing out 2
2. (11) Fore wing: last cubito-anal cross vein meeting Cu before the triangle 3
3. (6) Hind wing: triangle not fully retracted to the arculus 4
4. (5) Hing wing: triangle four sided . . . . . *Hypothemis*
5. (4) Hing wing: triangle three-sided . . . . . *Tetrathemis*
6. (3) Hing wing: triangle retracted to the arculus 7
7. (10) Hing wing: two cubito-anal cross veins present . . 8
8. (9) Fore wing: last antenodal continuous *Archaeophlebia*
9. (8) Fore wing: last antenodal discontinuous *Bironides*
10. (7) Hind wing: one cubito-anal present . . *Nannophlebia*

11. (2) Fore wing: last cubito-anal cross vein meeting Cu at the triangle 12
12. (23) Hind wing: anal loop wanting or of one cell row . . 13
13. (22) Fore wing: arculus between the second and third antenodal 14
14. (17) Hind wing: anal loop wanting 15
15. (16) Hind wing: one cell row behind A_2; fore wing: triangle four-sided . . . . . *Oda*
16. (15) Hind wing: two cell rows behind A_2; fore wing: triangle three-sided . . . . . *Orchithemis**
17. (14) Hind wing: anal loop present 18
18. (19) Hind wing: Cu_1 springing from hind angle of triangle *Eothemis*
19. (18) Hind wing: Cu_1 springing from outer side of triangle 20
20. (21) Hind wing: triangle not fully retracted to the arculus *Hylaeothemis*
21. (20) Hind wing: triangle retracted to the arculus *Calophlebia*
22. (13) Fore wing: arculus between first and second antenodal . . . . . *Argyrothemis*
23. (12) Hind wing: anal loop of two cell rows 24
24. (49) Hind wing: anal loop not distinctly foot-shaped . . 25
25. (40) Hind wing : a : b as 1 : 1 26
26. (27) Fore wing: triangle four sided . . . . . *Fylgia*
27. (26) Fore wing: triangle three-sided or with front side broken unevenly 28
28. (35) Fore wing: Cu_1 from hind angle of triangle 29
29. (30) Hind wing: Cu_1 from hind angle of triangle *Nesoxenia*
30. (29) Hind wing: Cu_1 from outer side of triangle 31
31. (34) Hind wing: two or more cubito-anals present 32
32. (33) Hind wing: three cubito-anals present . . *Allorhizucha*
33. (32) Hind wing: two cubito-anals present . . *Notiothemis*
34. (31) Hind wing: one cubito-anal present . . . . *Dasythemis*
35. (28) Fore wing: Cu_1 from outer side of triangle 36
36. (39) Fore wing: arculus between second and third antenodal 37
37. (38) Hind wing: three cubito-anals present *Amphithemis*
38. (37) Hind wing: two cubito-anals present . . *Neodythemis*
39. (36) Hind wing: arculus between first and second antenodal . . . . . *Microtrigonia*
40. (25) Hind wing: a : b as 1 : 2 41
41. (42) Hind wing: anal loop open at the toe . . *Brachygonia*
42. (41) Hind wing: anal loop closed at toe 43
43. (46) Fore wing: arculus beyond the third antenodal . . . 44

44. (45) Fore wing: triangle crossed; apical planate absent *Misagria*
45. (44) Fore wing: triangle without cross veins; apical planate present . . . . . *Pornothemis*
46. (43) Fore wing: arculus between the second and third antenodal 47
47. (48) Fore wing: triangle and subtriangle without cross veins; triangle as long as wide . . . . . *Micromacromia**
48. (47) Fore wing: triangle and subtriangle with cross veins; triangle twice as long as wide . . . . . *Agrionoptera*
49. (24) Hind wing: anal loop distinctly foot-shaped 50
50. (53) Fore wing: triangle pointing strongly out 51
51. (52) Fore wing: subtriangle of two cells . . . . . *Anatya*
52. (51) Fore wing: subtriangle of three cells . . . . . *Uracis*
53. (50) Fore wing: triangle nearly perpendicular to long axis of wing 54
54. (55) Fore wing: last antenodal cross vein continuous *Cannaphila**
55. (54) Fore wing: last antenodal discontinuous *Chalcostephia*
56. (1) Fore wing: triangle perpendicular to long axis or pointing in 57
57. (78) Hind wing: a : b as 1 : 1 58
58. (61) Hind wing: anal loop open at toe 59
59. (60) Fore wing: Cu_1 from hind angle of triangle *Nannothemis*
60. (59) Fore wing: Cu_1 from outer side of triangle *Nannophya*
61. (58) Hind wing: anal loop closed at toe 62
62. (67) Fore wing: arculus between second and third antenodal 63
63. (66) Fore wing: last antenodal continuous 64
64. (65) Hind wing: sole pointing out. Fore wing: subtriangle of three cells . . . . . *Aethiothemis*
65. (64) Hind wing: sole pointing in. Fore wing: subtriangle of one cell . . . . . *Elga*
66. (63) Fore wing: last antenodal discontinuous *Eleuthemis*
67. (62) Fore wing: arculus between the first and second antenodal 68
68. (71) Hind wing: Cu_1 from hind angle of triangle 69
69. (70) Hind wing: toe of anal loop rests on wing margin *Tyriobapta*
70. (69) Hind wing: toe of anal loop normal; radial planate with outer end turned forward enclosing three cells *Edonis*
71. (68) Hind wing: Cu_1 from outer side of triangle 72
72. (77) Fore wing: Cu_1 from hind angle of triangle 73
73. (74) Fore wing: triangle four-sided . . . . . *Nannodiplax*

74. (73) Fore wing: triangle three sided.....75
75. (76) Fore wing: last antenodal continuous...*Podothemis*
76. (75) Fore wing: last antenodal discontinuous..*Diplacodes*
77. (72) Fore wing: Cu_1 from outer side of triangle *Nephepeltia*
78. (57) Hind wing: a : b as 1 : 2 or more.....79
79. (80) Hind wing: A_2 very straight at base; patella long, usually more than one cell—(Trameini).....223
80. (79) Hind wing: A_2 not straight for any distance; patella not more than one cell long.....81
81. (120) Hind wing: bisector of anal loop slightly angulate making an angle of 30° or less at the ankle (Celithemini).82
82. (87) Fore wing: costa undulate before the nodus....83
83. (84) Hind wing: gaff longer than sole.....*Palpopleura*
84. (83) Hind wing: gaff shorter than sole.....85
85. (86) Hind wing: anal loop reticulate.....*Diastatops*
86. (85) Hind wing: anal loop with cross veins only *Zenithoptera*
87. (82) Fore wing: costa straight before the nodus.....88
88. (89) Fore wing: triangle about as wide as long.*Perithemis*
89. (88) Fore wing: triangle longer than wide.....90
90. (95) Hind wing: two or more cubito-anals present..91
91. (92) Hind wing: gaff longer than sole; fore wing: arculus between second and third antenodal.....*Thermochoria*
92. (91) Hind wing: gaff not longer than sole. Fore wing: arculus between first and second antenodal.....93
93. (94) Hind wing: anal crossing before origin of A_2 *Neurothemis*
94. (93) Hind wing: anal crossing not before A_2..*Planiplax*
95. (90) Hind wing: one cubito-anal present.....96
96. (117) Fore wing: M_2 smoothly curved.....97
97. (100) Hind wing: gaff longer than sole.....98
98. (99) Fore wing: radial planate enclosing four cells; last antenodal continuous.....*Selysiothemis*
99. (98) Fore wing: radial planate enclosing six to seven cells last antenodal discontinuous.....*Ephidatia*
100. (97) Hind wing: gaff not longer than sole.....101
101. (104) Fore wing: subtriangle of one or two cells....102
102. (103) Fore wing: subtriangle of one cell....*Aethriamanta*
103. (102) Fore wing: subtriangle of two cells; hind wing: anal loop with high heel.....*Philonomon*
104. (101) Fore wing: subtriangle of three or more cells..105
105. (108) Hind wing: anal crossing before origin of A_2....106
106. (107) Fore wing: medial planate subtending one cell row; last antenodal discontinuous.....*Brachythemis*
107. (106) Fore wing: medial planate subtending two cell rows; last antenodal continuous.....*Deielia*

108. (105) Hind wing: anal crossing not before A_2.....109
109. (114) Fore wing: subtriangle of three cells.....110
110. (113) Fore wing: triangle without cross veins.....111
111. (112) Hind wing: bisector with some angulation at ankle *Macrodiplax*
112. (111) Hind wing: bisector nearly straight....*Urothemis*
113. (110) Fore wing: triangle with cross veins...*Crocothemis*
114. (109) Fore wing: subtriangle of four or more cells....115
115. (116) Fore wing: triangle quite convex on outer side *Rhyothemis*
116. (115) Fore wing: triangle not convex on outer side *Celithemis**
117. (96) Fore wing: M_2 undulate.....118
118. (119) Fore wing: apical sector rising before the stigma; hind wing: triangle without cross veins....*Bradinopyga*
119. (118) Fore wing: apical sector rising under the center of the stigma; hind wing: triangle crossed..*Pseudoleon*
120. (81) Hind wing: bisector of anal loop making an angle of more than 30° at ankle.....121
121. (192) Hind wing: bisector making an angle of 30° to 50° 122
122. (143) Fore wing: M_2 nearly always undulate; matched antenodals more than 12; cross veins under stigma usually three or more; hind wing: sole usually out or perpendicular, rarely in—(Libellulini).....123
123. (126) Fore wing: M_2 smoothly curved.....124
124. (125) Hind wing: more than one cubito-anal present *Lyriothemis**
125. (124) Hind wing: one cubito-anal present....*Lathrecista*
126. (123) Fore wing: M_2 undulate.....127
127. (130) Hind wing: anal crossing before origin of A_2..128
128. (129) Hind wing: triangle not fully retracted to the arculus *Protorthemis*
129. (128) Hind wing: triangle retracted to arculus *Potamarcha*
130. (127) Hind wing: anal crossing not before A_2.....131
131. (142) Hind wing: gaff longer than sole.....132
132. (137) Hind wing: sole pointing out.....133
133. (134) Fore wing: arculus between the second and third antenodal.....*Cratilla*
134. (135) Fore wing: arculus between the first and second antenodal.....135
135. (136) Fore wing: bridge cross veins present....*Libellula*
136. (135) Fore wing: bridge cross veins absent.....*Orthemis*
137. (132) Hind wing: sole pointing perpendicular or in..138
138. (139) Fore wing: radial planate subtending one cell row *Lokia*
139. (138) Fore wing: radial planate subtending two cell rows 140

140. (141) Fore wing: cross veins under stigma two. *Orthetrum*
141. (140) Fore wing: cross veins under stigma more than two *Hadrothemis*
142. (131) Hind wing: gaff shorter than sole; toe open *Thermorthemis*
143. (122) Fore wing: M_2 usually smoothly curved; matched antenodals usually less than 12; cross veins under stigma usually less than 3; hind wing: sole usually pointing in—(Sympetrini) 144
144. (173) Hind wing: Cu_1 from hind angle of triangle 145
145. (148) Fore wing: arculus between second and third antenodals 146
146. (147) Fore wing: triangle without cross veins . . . . . *Porpax*
147. (146) Fore wing: triangle with cross veins . . . . *Rhodopygia*
148. (145) Fore wing: arculus between first and second antenodals 149
149. (150) Hind wing: triangle not fully retracted to the arculus *Raphismia*
150. (149) Hind wing: triangle retracted to the arculus . . 151
151. (172) Hind wing: triangle without cross veins 152
152. (157) Hind wing: sole pointing out 153
153. (156) Fore wing: radial planate subtending one cell row; bridge cross veins absent 154
154. (155) Fore wing: apical sector rising under first third of stigma . . . . . *Hemistigma*
155. (154) Fore wing: apical sector rising under middle third of stigma . . . . . *Austrothemis*
156. (153) Fore wing: radial planate subtending two cell rows; bridge cross veins present . . . . . *Pseudothemis*
157. (152) Hind wing: sole perpendicular or pointing in . . 158
158. (167) Fore wing: antenodal cross veins 11 to 17 159
159. (160) Fore wing: last antenodal continuous . . . . *Helothemis*
160. (159) Fore wing: last antenodal discontinuous 161
161. (162) Fore wing: radial planate subtending one cell row: last *Erythrodiplax**
162. (161) Fore wing: radial planate subtending two cell rows 163
163. (166) Fore wing: nodus before the mddle of the wing. . . 164
164. (165) Fore wing: row beneath subtriangle 1 + 2 *Brachymesia*
165. (164) Fore wing: row beneath subtriangle 1 + 3 *Cyanothemis*
166. (163) Fore wing: nodus beyond the middle of the wing *Trithemis*
167. (158) Fore wing: antenodal cross veins 6 to 9 168
168. (171) Fore wing: last antenodal continuous 169

169. (170) Fore wing: radial planate turned forward meeting R_s ..... *Leucorrhinia*
170. (169) Fore wing: radial planate not conjoining R_s *Brachydiplax*
171. (168) Fore wing: last antenodal discontinuous *Sympetrum*
172. (151) Hind wing: triangle with cross veins.... *Nesogonia*
173. (144) Hind wing: Cu_1 from outer side of triangle....174
174. (187) Hind wing: a : b as 1:1 or 1 : 2.....175
175. (180) Hind wing: anal crossing before A_2 176
176. (177) Fore wing: bridge cross veins present.. *Micrathyria**
177. (176) Fore wing: bridge cross veins absent.....178
178. (179) Hind wing: no elongate cells in anal angle *Diplacina**
179. (178) Hind wing: elongate cells in anal angle.... *Acisoma*
180. (175) Hind wing: anal crossing not before A_2.....181
181. (182) Fore wing: a long veinless space between R_1 and M_1 in the area before and under the stigma.. *Pachydiplax*
182. (181) Fore wing: spacing of cross veins before and under stigma normal.....183
183. (184) Fore wing: subtriangle of one cell; row beneath 1 + 1 *Oligoclada*
184. (183) Fore wing: subtriangle of three cells; row beneath 1 + 2.....185
185. (186) Fore wing: last antenodal continuous.... *Oxythemis*
186. (185) Fore wing: last antenodal discontinuous.. *Indothemis*
187. (174) Hind wing: a : b as 1 : 3.....188
188. (191) Fore wing: radial planate subtending one cell row 189
189. (190) Fore wing: nodus before the middle of wing *Erythemis*
190. (189) Fore wing: nodus at the middle of the wing *Rhodothemis*
191. (188) Fore wing: radial planate subtending two cell rows *Lepthemis*
192. (121) Hind wing: bisector making an angle of between 50° and 60°.....193
193. (196) Hind wing: anal crossing before A_2.....194
194. (195) Hind wing: two cubito-anals present.... *Atoconeura*
195. (194) Hind wing: one cubito-anal present *Pseudagrionoptera*
196. (193) Hind wing: anal crossing not before A_2.....197
197. (202) Hind wing: two cubito-anals present.....198
198. (201) Fore wing: last antenodal discontinuous; hind wing: a : b as 1 : 2.....199
199. (200) Hind wing: last cell row in anal angle not taller than wide..... *Lanthanusa*
200. (199) Hind wing: last cell row in anal angle taller than wide..... *Gynothemis*

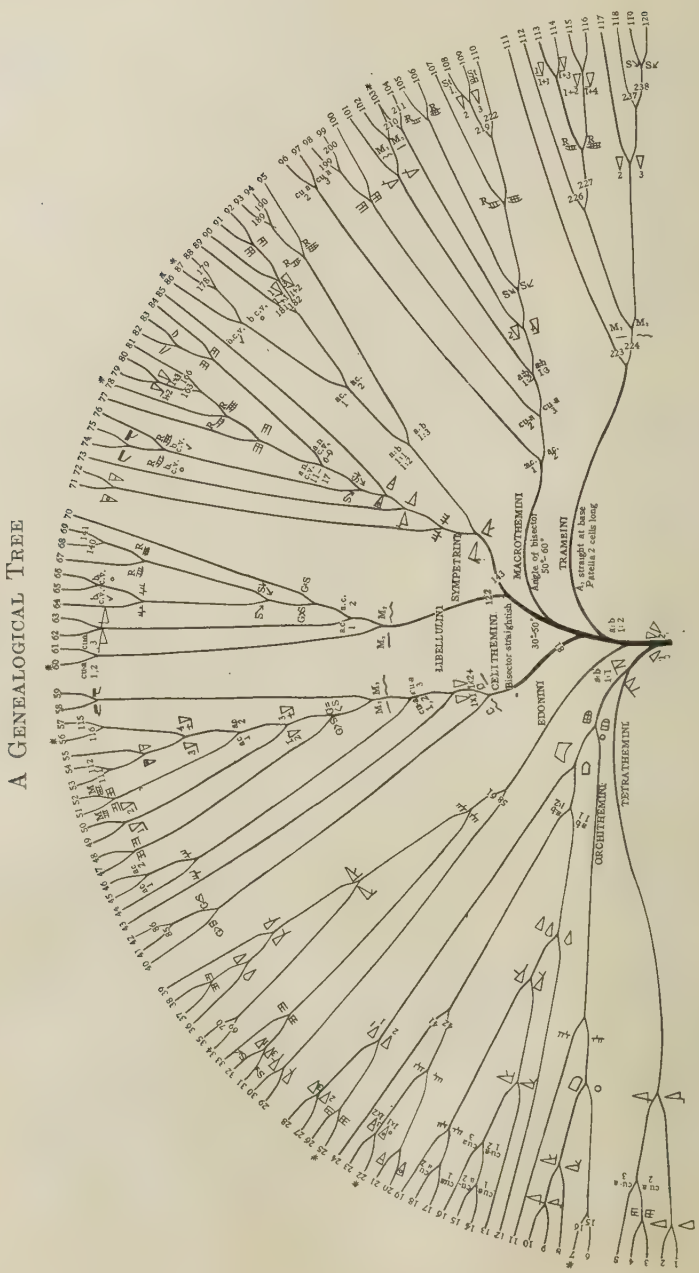
201. (198) Fore wing: last antenodal continuous; hind wing: a : b as 1 : 3 . . . . . *Thalassothemis*
202. (197) Hind wing: one cubito-anal present 203
203. (208) Hind wing: a : b as 1 : 2 204
204. (205) Hind wing: triangle not fully retracted to the arculus *Huonia*
205. (204) Hind wing: triangle retracted to the arculus 206
206. (207) Fore wing: M_2 undulate . . . . . *Dythemis*
207. (206) Fore wing: M_2 smoothly curved . . . . . *Macrothemis*
208. (203) Hind wing: a : b as 1 : 3 209
209. (212) Fore wing: subtriangle of one or two cells 210
210. (211) Fore wing: elongate cells between M_1 and M_2 extending more than half way to stigma . . . . *Macrothemis**
211. (210) Fore wing: elongate cells between M_1 and M_2 extending less than half way to stigma . . . . . *Zygonyx*
212. (209) Fore wing: subtriangle of three or more cells . . 213
213. (216) Hind wing: sole perpendicular or pointing out . . 214
214. (215) Fore wing: radial planate subtending one cell row; gaff twice as long as sole; rows behind anal loop three *Celebothemis*
215. (214) Fore wing: radial planate subtending two cell rows; gaff equal to sole; rows behind anal loop four *Onychothemis*
216. (213) Hind wing: sole pointing in 217
217. (218) Fore wing radial planate subtending one cell row *Brechmorhoga*
218. (217) Fore wing: radial planate subtending two cell rows 219
219. (222) Hind wing: cell rows behind anal loop three or four 220
220. (221) Fore wing: triangle nearly perpendicular; stigma long . . . . . *Olpogastra*
221. (220) Fore wing: triangle pointing in; stigma short *Scapanea*
222. (219) Hind wing: cell rows behind anal loop six or more *Paltothemis*

(*Continued on page 183*)

Explanatory Note Relative to Following Diagram and Tables

The short-hand characters used in the diagram and in the tables following it will be understood at a glance if it be borne in mind that the right wings only are used, and that these small diagrams are but crude pictorial representations of the characters used. The abbreviations F. W. and H. W. are used for fore wing and hind wing respectively, to save space.

A GENEALOGICAL TREE

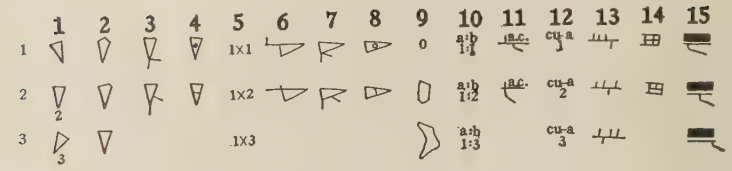


EXPLANATIONS OF THE SYMBOLS USED

	1	2	3	
1	1	2	3	F. W. Direction in which the triangle points; *out, perpendicular* (to vein Cu), or *in* (Fig. 3 G)
2				F. W. Front side of triangle *broken equally, unequally* or *not at all.*
3				F. W. Origin of vein Cu_1, *from apex* of triangle or *from outer side.*
4				F. W. Dividing cross veins in triangle *absent* or *present.*
5	1×1	1×2	1×3	F. W. Proportions, *length by width,* of triangle as stated.
6				H. W. Position of triangle *beyond* or *retracted to* the arculus.
7				H. W. Origin of Cu_1, *from hind angle* of triangle or *from outer side.*
8				H. W. Dividing cross veins in triangle *absent* or *present.*
9	o			H. W. Anal loop *wanting, gland-shaped,* or *foot-shaped.*
10	a:b 1:1	a:b 1:2	a:b 1:3	H. W. Basal spaces of anal loop separated by the bisector as measured on vein A (Fig. 4 I).
11	a.c.	a.c.		H. W. Position of anal crossing in relation to base of vein A_2 *before,* or *opposite.*
12	cu-a 1	cu-a 2	cu-a 3	H. W. Cubito-anal cross veins before the triangle: grades—not actual numbers (see p. 00).
13				F. W. Position of arculus in relation to first three antenodals *beyond the third, the second,* or *the first* (see p. 00).

EXPLANATION OF THE SYMBOLS USED

	1	2	3	
14				F. W. Last antenodal *continuous* or *discontinuous.*
15				F. W. Origin of the apical sector, *before, under* or *beyond* the middle third of stigma.
16				F. W. Position of last cubito-anal cross vein, inclined to *meet triangle,* or *not.*
17				H. W. Front side of triangle *broken* or *not.*
18				H. W. Cell rows in anal loop *one* or *two.*
19	G>S	G=S	G<S	H. W. Relative length of gaff and sole in anal loop; *gaff greater, equal,* or *less than* sole.
20	S↘	S↓	S↙	H. W. Direction sole line takes its rear end pointing *out, perpendicular* to vein M_4, or *in.*
21	M_1—	M_1~		F. W. Course of vein M_2 *smoothly curved* or *undulate.*
22	b.c.v. ✓	b.c.v 0		F. W. Extra cross veins enclosed by bridge (i. e. more than one), *present* or *absent.*
23	r.v.0	r.v.✓		F. W. Reverse vein *not well developed* or *well developed.*
24				F. W. Cell rows above planate *one* or *more,* (M indicates medial, and R, radial planate).
25				F. W. Radial planate running out *more or less parallel* to R_s and radial planate *conjoining* R_s.
26	1 1+1	2 1+2	3 1+3	F. W. Cells in subtriangle and in row beneath, it as stated.



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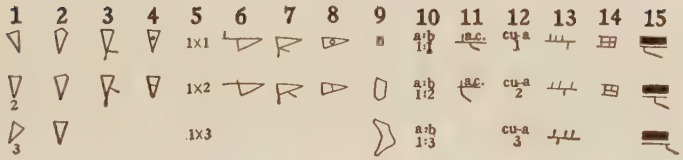

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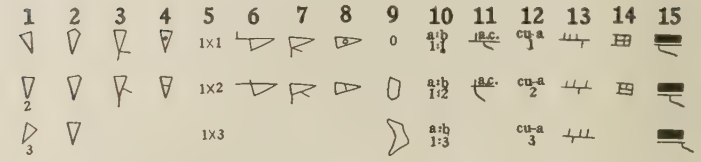

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(*Continued from page 177*)

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IX. Notes on the Classification of the Subfamily

In this paper we have purposely limited our studies to venation alone. We have not taken the evidence from other parts into account at all. But we believe that the final classification will be attained when other parts receive like comparative treatment, when the immature stages have been made known, and when the facts are all assembled. The facts of venation we find in the main lend support to the system proposed by Ris. Many of the apparent differences between our arrangement of the genera and his are due to the limitations of a linear series for expressing multiple lines of adaptive radiation. A few comments may be made on our own groupings.

Tribe *Tetrathemini*

This tribe is not very homogeneous. One expects diversity at the beginning of a phylogenetic series. It includes relic

genera, left-overs from various evolutionary experiments. All agree in one very primitive character; the subtriangle is still a four-sided cell, the cubital vein still forming its front border. We agree with Ris in placing *Hypothemis* at the foot of the series, since it has preserved the earlier form of nearly all the most important venational characters. Yet it is far from primitive in its long fusion of sectors of the arculus, in the progression of vein Cu_1 up the outside of the triangle and in the slant of the cross-veins under the stigma.

Tetrathemis is a very distinct and consistent genus having the last cubito-anal cross-vein of the fore wing often matched against a supertriangular cross-vein, and an anal loop of three or four cells.

Bironides is rather remarkable for the developmental contrast between fore and hind wing. The fore wing is perhaps the most primitive of the entire series; the hind wing in its long stalked sectors of the arculus, its half antenodal cross-vein, and its elevation of Cu_1 at base, is rather specialized.

Tribe *Orchithemini*

Under this tribal name we assemble all those additional genera in which the triangle of the fore wing points outward. *Argyrothemis*, *Fylgia* and *Dasythemis* belong here, rather than in the higher position where Ris placed them; and some of the species Ris left in *Diplacina* seem to belong here.

The gaff in *Nesoxenia lineata* is unique in direction, not at all agreeing with the type species of that genus. If the wing figured by Ris (p. 127) is normal it represents a new genus. Another mixed genus is *Micromacromia*, in which *M. afra* (Ris, p. 75) has an anal loop differing markedly from that of the type species.

Brachygonia is one of the most unique, venationally, of the Libelluline genera, in the development of its anal loop, the cells on the two sides of its bisector being elongated in opposite directions, and the apex incomplete. Large cells in area M_1 and approximally placed arculus and nodus are features of considerable specialization.

The genus *Cannaphila* contains two species that show considerable differences as pointed out by Ris (p. 294). In *C. vibex* the triangle points outward far more than in the type species.

The outward inclination of the triangle is most marked in *Uracis*, where it is accompanied by a wide anal loop with a big "heel" and a spur vein extending outward from the bisector into the heel.

Tribe *Edonini*

Under this tribal name we assemble a group of small genera in which the basal spaces of the anal loop beside the bisector spaces *a* and *b* (see Fig. 4) measured along the anal vein are approximately equal. In all the following tribes these spaces are very unequal, *b* being two or more times *a*. Members of this tribe have for the most part a short strong radial planate, turned forward at its ends to enclose a row of cells that is often of a definite number.

Two genera of this tribe, *Nannodiplax* and *Nannothemis* (Fig. 4, G) stand apart from all the others in the common possession of an anal loop that is not a true loop. The lower end remains open, veins A_1 and A_2 not being conjoined distally. Between the two genera this is a strong bond of union. Other common characters were pointed out by Brauer, Karsch and Kirby.

Tribe *Celithemini*

In this tribe we place those remaining genera which have the bisector of the anal loop nearly straight, the portion beyond the "ankle" being bent out of line with the base by an angle of usually less than 30°. In this tribe there is a preponderance of forms with colored wings. Often the venation is copious, the triangle of the front wing points far inward and the reverse cross vein is well developed.

Diastatops, *Zenithoptera* and *Palpopleura* have long been set apart on the common possession of a costal vein that is undulate before the nodus. This alone is hardly a character of tribal value. It fails in species of *Palpopleura*. Ris included *Perithemis* with these three genera and on venational evidence we add others.

Perithemis shows the maximum bending inward of the triangle of the fore wing. *Neurothemis* and *Celithemis*, especially the former, show remarkable range in the number and regularity of the cross-veins in the various wing areas.

Tribe *Libellulini*

Next comes the typical tribe, for defining which a combination of characters is used, because no single one holds throughout. Vein M_2 is undulate (except in *Lyriothemis* and *Nesoxenia*). Vein Cu_1 is never elevated on the outer side of the triangle in the hind wing. The sole line points outward. There are three or more cross-veins behind the stigma. The fore wing triangle is crossed. Matched antenodal cross veins are numerous (fifteen or more) and the anal loop is of two cells row only (without intercalated cells).

In *Lyriothemis* the type species, *L. Cleis*, has the tip of the two pairs of parallel veins (M_2 and R_s, M_3 and M_4) strongly hooked. *L. acigastra* seems to belong in the preceeding tribe near *Tyriobapta*, and *L. pachygastra* in the next following tribe near *Porpax*.

In *Protorthemis woodfordi* the anal loop is hardly footshaped, having little development of the toe, and in *Thermorthemis* the toe is incomplete, the tip of vein A_2 being lost. This last character occurs again in *Zyxomma*.

Ris' new species *Orthemis regalis* seems to be a true *Libellula*.

Tribe *Sympetrini*

This tribe includes some numerically dominant genera of the dragonflies. Vein M_2 is not undulate (except in species of *Trithemis*); there are two cross-veins under the stigma, rarely more; the matched antenodal cross-veins are fewer than twelve (except in *Lepthemis*). The sole line points in (except in species of *Erythrodiplax*). Vein Cu_2 of the hind wing often springs from the outer side of the triangle.

Several of the genera as left by Ris are obviously heterogeneous; notably *Micrathyria*, *Diplacina* and *Erythrodiplax*. *D. smargadina* seems to belong to *Dasythemis* and *M. dido* near it. In *M. dictyma*, also, the fore wing triangle points out, but spaces a : b are as 1 : 2, and therefore, more like *Agrionoptera*.

Perhaps a new genus should be made for *D. militaris*.

In *Erythrodiplax*, *E. minuscula* and *E. maculosa* are not congeneric with the type species nor with each other. And in *Oligoclada*, *O. sylvia* is aberrant, and apparently near *Nephepeltia*.

The anal loop at its toe in *Raphisma* rests on the anal margin

of the wing, as in *Tyriobapta*. Perhaps it belongs nearer to that genus than we have placed it.

Tribe *Macrothemini*

In this tribe we have grouped those genera that have the maximum angulation of the bisector of the anal loop, the portion beyond the "ankle" making with the base an angle of 50° or more. They are mostly fine large forms, more or less metallic in their coloration of body, and Corduline in aspect.

The large genus *Macrothemis* includes so wide a range of forms it is difficult to place them all in a key based on venation alone. Three species at least have two cubito-anal cross-veins in the hind wing; the other species have one.

Tribe *Trameini*

Lastly, the tribe Trameini includes some of the largest as well as the most specialized and strong flying Libellulines. The base of vein A_2 is straight for a distance at its base about equal to the length of the long patella, and the latter is usually composed of two or more cells. Often behind the patella there are extra sectors springing from vein A_2, supporting the broad anal angle of the hind wing. The apex of the wing is often pointed, with a small trapezoidal stigma.

X. Systematic List of Genera

The following is a list of the 120 genera of the Libellulinae arranged in the order of this classification. The number to the left indicates their place in our system; the one to the right, their place in that of Ris.

1. Hypothemis (1)
2. Tetrathemis (2)
3. Archaeophlebia (3)
4. Bironides (4)
5. Nannophlebia (5)
6. Oda (6)
7. Orchithemis (15)
8. Eothemis (10)
9. Hylaeothemis (8)
10. Calophlebia (9)
11. Argyrothemis (52)
12. Fylgia (53)
13. Nesoxenia (20)
14. Allorhizucha (14)
15. Notiothemis (13)
16. Dasythemis (35)
17. Amphithemis (16)
18. Neodythemis (12)
19. Microtrigonia (7)
20. Pornothemis (17)
21. Misagria (34)
22. Micromacromia (11)

23. Agrionoptera (22)
24. Brachygonia (41)
25. Cannaphila (33)
26. Chalcostephia (46)
27. Anatya (60)
28. Uracis (59)

29. Nannothemis (51)
30. Nannophya (40)
31. Aethiothemis (44)
32. Elga (56)
33. Eleuthemis (49)
34. Tyriobapta (42)
35. Edonis (55)
36. Nannodiplax (62)
37. Podothemis (58)
38. Diplacodes (64)
39. Nephepeltia (54)

40. Palpopleura (38)
41. Diastatops (36)
42. Zenithoptera (37)
43. Perithemis (39)
44. Thermochoria (48)
45. Neurothemis (70)
46. Planiplax (84)
47. Selysiothemis (120)
48. Ephidatia (116)
49. Aethriamanta (118)
50. Philonomon (80)
51. Brachythemis (71)
52. Deielia (72)
53. Macrodiplax (119)
54. Urothemis (117)
55. Crocothemis (68)
56. Celithemis (83)
57. Rhyothemis (111)
58. Bradinopyga (69)
59. Pseudoleon (66)

60. Lyriothemis (19)
61. Lathrecista (21)
62. Protorthemis (23)
63. Potamarcha (25)
64. Cratilla (24)
65. Libellula (31)
66. Orthemis (32)
67. Lokia (26)
68. Orthetrum (30)
69. Hadrothemis (29)
70. Thermothemis (28)

71. Porpax (50)
72. Rhodopygia (77)
73. Raphismia (45)
74. Hemistigma (47)
75. Austrothemis (86)
76. Pseudothemis (87)
77. Helothemis (93)
78. Erythrodiplax (65)
79. Brachymesia (85)
80. Cyanothemis (74)
81. Trithemis (94)
82. Leucorrhinia (82)
83. Brachydiplax (43)
84. Sympetrum (79)
85. Nesogonia (78)
86. Micrathyria (61)
87. Diplacina (18)
88. Acisoma (63)
89. Pachydiplax (81)
90. Oligoclada (57)
91. Oxythemis (27)
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DESCRIPTIONS OF NEW MICROLEPIDOPTERA

BY ANNETTE F. BRAUN

Cincinnati, Ohio

The present paper comprises descriptions of ten new species of Microlepidoptera most of them reared. All are rather sharply characterized, even the species belonging to the difficult genus *Tischeria*. The knowledge of the life history in the case of the reared species, will always render recognition certain.

Heliozelidae

Antispila voraginella new species

Head and thorax dark brown, almost black, antennae exceeding half the wing length in the male, dark brown throughout. Fore wings dark brown, with reddish and greenish reflections; cilia distinctly purple in basal half, paler and gray in outer half. An oblique, pale golden fascia at basal fourth, broadest on dorsum; obliquely placed costal and dorsal triangular spots just beyond middle; a pale golden spot at apex. Hind wings dark brown, coarsely scaled. Legs blackish. Underside of abdomen paler, silvery in male. Expanse, 6 mm.

Type (♂) and ten paratypes (1 ♂, 9 ♀) reared from miners of leaves of wild grape (*Vitis arizonica*), Zion Canyon, Utah. The mines are very common, the whitish blotches either single or formed from the confluence of several mines; as many as twenty or twenty-five pupal cases may be cut from a single leaf. The pupal case is broadly elliptical, often lopsided. On July 24, most of the cases had already been cut out, and only a few mining larvae were secured. The moths emerged April 9 to 16 of the following spring, the date of emergence of the type, April 9.

This species is separated from the similarly marked *Antispila ampelopsifoliella* Chambers by the dark head, entirely dark antennae, the longer antennae of the male, less red in the color of the fore wing, and the dark coarsely scaled hind wings.

Type and nine paratypes in the writer's collection; one paratype in the Academy of Natural Sciences of Philadelphia.

Coptodisca quercicolella new species

Face pale silvery gray, head strongly tinged with pale golden on vertex and posteriorly; antennae pale gray at base, dark brown toward apex. Thorax and basal half of fore wing silvery gray; wing abruptly darkening at the middle, where the scales are dark reddish bronze and black-tipped. This dark area occupies the whole of the outer dorsal half of the wing, and extends upward in varying width to the middle of the costa. Its outer edge in costal half is concave and sharply defined, and forms the inner black margin of a triangular orange yellow patch bordering the first and brilliant silvery costal spot; very rarely the line of black scales does not reach costa. This yellow patch and the more or less quadrate yellow area immediately posterior to the first silvery costal spot and limited outwardly by the inner black border of the second silvery spot, are the only orange yellow areas in the otherwise dark ground color of the apical half of the wing. A dorsal silvery spot opposite first costal and a few silvery scales on termen below apex. Apical black spot preceded by metallic blue scales; the usual black scales opposite apex and black pencil in the whitish cilia. Hind wings dark gray. Abdomen dark gray, with reddish and greenish iridescence. Expanse, 5 mm.

Type (♂) and five paratypes, Cornville, Arizona, 3400 ft., May 1 to 10; twenty paratypes, Prescott, Arizona, 5300 ft., May 14 to 25; all reared from mines on *Quercus* sp., received from Mr. Harold R. Brisley of Clemenceau, Arizona.

The mines are very small, at least when in evergreen leaves, and of the usual *Coptodisca* type.

This species is the most easily differentiated of the genus; it is at once recognized by the sharply outlined triangular shape of the orange yellow patch preceding the first silvery costal spot.

Paratypes have been placed in the Academy of Natural Sciences of Philadelphia and in the California Academy of Sciences.

Glyphipterygidae

Choreutis immutabilis new species

Palpi grayish ocherous, brush whitish and fuscous dusted, two parallel white bands crossing tip of second segment and brush, third segment with extreme base and two annuli darker. Antennae blackish with whitish annulations. Head and thorax brownish, the latter marked with three longitudinal metallic lines. Fore wings decidedly broad, basal fourth bright brownish ocherous, outer margin of ocherous area nearly straight, and

farther from base on costa; pinkish or bluish metallic subcostal and median longitudinal streaks. Outer three-fourths of wing uniformly clothed with broadly white-tipped dark brownish fuscous scales, the general effect being a grayish white with dark fuscous dusting; sometimes a faint golden tinge on middle costal region. The outer half of the wing is marked with patches of metallic scales superimposed on velvety black, the most prominent being three in a row in the lower half of the wing; the smallest of these within the cell, a larger angulated patch at end of cell, a third transverse, parallel to termen. A curved metallic streak at two-thirds of costa. In apical part of wing, three more or less broken black streaks ending in metallic scales. Cilia dark gray, metallic. Underside gray, with a single white spot at two-thirds of costa. Hind wings uniform brownish gray above, apex broadly rounded, termen evenly rounded; underside with white costal spot only or with two white bands. Underside of body whitish. Legs brownish fuscous, banded with white. Expanse, 15 to 17 mm.

Type (♂), Fredalba, San Bernardino Mountains, California, August 21; ten paratypes (4 ♂, 6 ♀), same locality, August 8 to August 30, all collected by G. R. Pilate.

This species is characterized by the uniform coloration of the outer three-fourths of the fore wings, without any sign of paler fascia or streak at two-thirds, the broad fore wings and uniformly colored upper surface of the hind wings.

Type and eight paratypes in the writer's collection; one paratype in the Academy of Natural Sciences of Philadelphia; one paratype in the California Academy of Sciences.

Plutellidae

Acrolepia reticulosa new species

Head grayish brown with yellow and whitish hairs intermingled; tips of segments of labial palpi pale, antennae annulate with dark brown. Fore wings ashy brown, with a greater or less mixture of white scales; marked with transverse, irregular and broken lines of dark brown and black scales. A patch of white scales in fold near base is divided by a line of blackish scales; before middle of dorsum is a large quadrate pure white patch extending nearly half way across the wing, bordered on each side by black scales; three small white dorsal spots beyond, the third at the tornus; three small white costal streaks in the apical third of the wing; a white streak on termen just before apex extends out through the cilia. The apical fourth of the wing is heavily dusted with white scales; it is sometimes almost pure white, except on the margins. On the wing before the apex, is an elongate black spot, and beneath it, usually, a smaller black

spot. Cilia brown, with a coppery luster. Hind wings gray. Legs pale ashy, segments white-tipped. Abdomen brownish at base, shading posteriorly to dark fuscous; tuft yellowish. Expanse, 16 to 17 mm.

Type (♂), Old Faithful Camp (7400 ft.), Yellowstone National Park, July 4, 1924; two paratypes (♂), same locality; all taken at the edge of the lodgepole pine forest.

Types in the writer's collection.

Gracilariidae

Phyllocnistis finitima new species

Palpi and head shining pale grayish metallic; antennae dark gray, basal segment not enlarged into an eye-cap. Fore wings elongate, dorsal two-thirds for over half the wing length shining pale gray or silvery, the silver color predominating above the fold, thus forming a somewhat contrasting silvery white basal streak, which extends beyond the middle of the wing and is margined along its upper side and around its tip to the fold with dark brown. The gray basal area is scarcely or not at all convex toward costa. Remainder of the wing bright reddish orange. From basal sixth of costa, a very oblique almost longitudinal silvery white costal streak extends to beyond the middle of the wing; its dark inner margin extends to the base and lies parallel to the margin of the basal gray area. An angulate silvery fascia beyond middle, dark margined on both sides, of almost equal width throughout, scarcely broadening on either wing margin. A black apical spot, preceded by silvery scales; four black lines radiate from it into the white cilia. Between these black lines and the margin of the silvery fascia are two more dark lines in the costal cilia. Basal half of cilia along termen dark brown. Hind wings brownish gray. Legs silvery gray outwardly, dark brown above, spurs silvery. Expanse, 7 to 8 mm.

Type (♂), and eleven paratypes (♂, ♀) reared from mines on leaves of *Senecio* sp., White House Canyon, Santa Rita Mountains, Arizona. The mine is identical in character with that of *Phyllocnistis insignis* on *Senecio*. The mines were collected March 17; imagoes emerged from March 20 to April 5; the date of emergence of the type is March 20.

This species is close to *insignis*, with which it agrees in structure, general color and type of markings. It is however a much larger insect, with much more elongate wings, and markings differently proportioned; the most striking differences are the straight upper side of the gray basal area in *finitima* (this side being decidedly convex toward costa in *insignis*), the greater

length of the gray basal area, and the even width of the angulate fascia.

Type and ten paratypes in the writer's collection; one paratype in the Academy of Natural Sciences of Philadelphia.

Lyonetiidae

Bucculatrix sexnotata new species

Face shining yellowish white, tuft orange in front, shading to dark brown behind, eye-caps shining yellowish white, antennal stalk buff, spotted with dark brown above. Thorax and fore-wings very dark brown, faintly shining. Six silvery white spots placed as follows: an oblique spot from base of costa to fold; oblique triangular costal spots before middle and at three-fourths; triangular dorsal spots at one-third and before tornus, each a little anterior to the corresponding costal spot; the sixth spot at apex. A line of dark scales runs through the cilia along termen. Hind wings brown. Legs dark brown, hind tibiae with yellowish hairs, tarsi paler, yellowish. Abdomen dark brown above, paler beneath, tuft orange. Expanse, 7 mm.

Type (♂) and one paratype (♀) reared from larvae on leaves of *Aster divaricatus*, Powell County, Kentucky, collected October 12.

The mine is a short, narrow, transparent linear mine, a little over a centimeter in length; after leaving the mine, the larva feeds on the underside of the leaf, eating out patches, but leaving the upper epidermis untouched. Cocoon brownish, shining. The type emerged April 18, the paratype April 27 of the following spring.

Nearest *Bucculatrix locuples* Meyrick.

Types in the writer's collection.

Bucculatrix cuneigera Meyrick

1919. *Bucculatrix cuneigera* Meyrick, Exotic Microlepidoptera, II, p. 288.
1920. *Bucculatrix errans* Braun, Ent. News, XXXI, p. 77.

I take this opportunity to state that a comparison with type specimens of *B. cuneigera* Meyrick shows the above synonomy.

Tischeria cinereotunicella new species

Face and scale flap of basal segment of antennae whitish, vertex yellow. Thorax and base of fore wings (in ♂ type and ♀ allotype) pale lemon yellow, shading gradually deeper to an orange yellow, with the tips of the scales in the apex microscopically brownish, the minute brownish tips not producing a

dusted effect, however. The entire wing is shining, with a strong blue luster. One smaller male paratype shades to a much deeper almost reddish brown color in the apex and along the outer half of the costal margin, and the scales in the apical half of the wing are distinctly brown-tipped. Underside of fore wings brownish, without sex scaling. Hind wings pale gray, with distinctly yellow cilia, except in the male paratype where the wings are darker and cilia gray, scarcely tinged with yellow; very narrowly lanceolate in both sexes, less than half the width of fore wing, except at extreme base. Abdomen above, in male yellowish, shaded with fuscous, in female bright yellow; beneath, dusted with dark brown. Expanse, 10.5 mm. (type and allotype); 8 mm. (paratype).

Type (♂), and allotype (♀), Clermont County, Ohio; paratype (♂), Brown County, Ohio: all reared from large gray mines on oak, *Quercus bicolor*, and *Quercus imbricaria*. A fourth specimen, apparently this species, was accidentally reared together with specimens of *Tischeria* (*Coptotriche*) *zelleriella*.

The mine starts as a narrow gray line and very gradually enlarges into a trumpet-shaped mine, with the frass, which is retained within the mine, crowded down into the beginning of the mine or deposited in concentric crescents on the loosened gray epidermis; toward the end of the mining period, the mine broadens out and becomes paler, but still keeps the peculiar grayish tint, and is marked with curved dark lines. Pupation takes place in a wrinkled chamber, with epidermis torn at the ends, as in *zelleriella*.

The mines from which the type specimens were reared were collected in September; the imagoes emerged the following April; the type and the allotype, April 28; paratype, April 25.

The habits of the larva, the head structure of the moth, the general shape and color of the fore wing ally this species to *zelleriella;* from which it is at once separated by the narrowly lanceolate hind wings of both sexes.

The suspicion arises that this may be Chambers' *Tischeria castaneaeella;* but it is scarcely possible that Chambers would have failed to notice the strikingly peculiar color of the mine. In view of the certainty of the association of the sexes in my reared specimens, and the definite notes upon the life history, it has seemed better to describe this as a new species.

Types in the writer's collection.

Tischeria mediostriata new species

Face and vertex whitish, lateral scales of the tuft brownish; antennal flap orange yellow. Fore wings bright orange yellow, faintly shining, with a broad, sharply limited lemon yellow stripe from base to two-thirds, nearer the dorsal margin, its lower edge parallel to dorsal margin, its upper edge diverging from costa; a patch of faint dark dusting at tornus, a scattered line around apex; sometimes faint dusting on middle of costa. Fore wings straw colored beneath, without sex scaling. Hind wings whitish, with pale yellow cilia; more than half the width of the fore wings, evenly lanceolate. Abdomen yellow above, whitish and undusted beneath. Expanse, 9 mm.

Type (♂), reared from a miner on a leaf of *Quercus gambelii*, North Rim, Grand Canyon, Arizona, 8100 ft.; allotype (♀), from *Quercus* sp., Fredalba, San Bernardino Mountains, California; two paratypes (♂, ♀), Fredalba, California; all in the writer's collection.

The mine is a small elongate whitish or yellowish blotch at the margin of the leaf on the upper side; at pupation the epidermis is wrinkled and the margin of the leaf bent over in a slightly spiral twist. The mine from the Grand Canyon was found July 27 and the imago emerged August 6; the mines from the San Bernardino Mountains were collected at the beginning of August, and the moths emerged August 24–29.

This species may be at once separated from all other species by the clear lemon yellow undusted and sharply limited basal stripe of the fore wing. From *Tischeria citrinipennella* Clemens, its closest ally in character of mine and in appearance of imago, it is further distinguished by the absence of fuscous spots at the base of the wings. *Tischeria nubila*, to which it is also allied, has a very different mine.

Tischeria omissa new species

Face straw colored, vertex pale straw colored or deeper, more ocherous, with grayish scales intermixed. Antennae fuscous; ciliation in male long at base, becoming shorter outwardly. Wings straw colored, deepening outwardly, and faintly tinged with orange around apex and in cilia. The wings are more or less densely dusted with blue-gray scales, which in some places cluster into definite markings. The more constant of these markings are the following: a small patch near base within the costal margin, a larger oblique patch at basal third, lying also within the costal margin, three irregular connected patches crossing the wing obliquely from beyond middle of costa to

tornus; a patch within the dorsal margin near base, an oblique patch near middle of dorsum; a patch covering the apex of the wing. In darker specimens, the dusting is especially heavy at base of wing and along basal half of costa, obliterating the above-mentioned clusters of dark scales near base; in very pale specimens, the dark markings are much shrunken in size and the wing between them is almost undusted. Hind wings varying from pale to dark gray. Legs yellowish gray, shaded with dark fuscous. Abdomen dark fuscous. Expanse, 10 to 11 mm.

Type (♂), and sixteen paratypes (♂, ♀) reared from mines on hollyhock (*Althaea rosea*), Berkeley, California, received by the writer from Mr. Wyatt W. Jones; eight paratypes (♂, ♀) in the collection of the California Academy of Sciences, also reared on hollyhock and received from Mr. Jones. Two paratypes from the author's series have been placed in the Academy of Natural Sciences of Philadelphia.

There are several generations a year; in the series are specimens emerging in May, August and October; the date of the type is May 1. The mine is a whitish, translucent blotch, with pupation taking place in a small wrinkled, silkened-lined chamber. The mines occur in great numbers on the leaves together with mines of *Bucculatrix althaeae* Busck.

Of the group of *Tischeria heliopsisella*, but distinguished by the clear straw yellow of the fore wing and blue-gray scales with no mixture of white.

Nepticulidae

Nepticula virgulae new species

Tuft brownish ocherous, faintly tinged with red between the yellowish white eye-caps; antennal stalk dark brownish fuscous. Thorax and fore wings almost black; a faint purple tinge on thorax and base of fore wings; at middle of wing a brilliant silvery slightly convex fascia, usually broadest on the dorsum. Cilia whitish; marginal line of scales thus sharply defined around apex. Hind wings gray, cilia darker; in the male with a narrow yellowish chitinous plate on the upper side of costa of hind wing from base to near middle. Underside of body and legs dark silvery gray. Expanse, 4 mm.

Type (♂) and allotype (♀), Clinton County, Ohio; two paratypes (♂, ♀), Clermont County, Ohio; all reared from miners of leaves of hazel (*Corylus americana*). The date of emergence of the type is April 24; that of the allotype May 15; the mined leaves were collected in the preceding August and

September. The mine is long, gradually broadening to a width of 1½ or 2 mm. at its end; with frass in a broad tract or more or less scattered. Larva green; cocoon reddish brown. The mine is considerably broader than the body of the larva, much broader than that of *Nepticula corylifoliella*, which often occurs with this species, but narrower however than the mine of *Nepticula ostryaefoliella*.

Superficially, *Nepticula virgulae* is very close to *Nepticula rubifoliella* and *Nepticula nyssaefoliella;* but is separated from both by the presence of the chitinous plate on basal half of costa of hind wing of male; it is further separated from *nyssaefoliella* by the smaller size, darker hind wings, and absence of androconia on the hind wings of the male. Except for the chitinous plate it is indistinguishable from *rubifoliella*. The chitinous plate of this species is structurally identical with that found in *Nepticula platanella*, with which this species also agrees in venation.

Types in the writer's collection.

THE GENUS MICROSTYLUM IN MADAGASCAR
(DIPTERA: ASILIDAE)

BY S. W. BROMLEY

The genus *Microstylum* was proposed by Macquart[1] in 1838, to include a natural group of species previously placed in the genus *Dasypogon*. The genus received its name from the fact that the species bear a minute style on the third joint of the antenna. In addition to this, it differs from related genera of the Dasypogoninae in the following combination of characters: the long proboscis, longer than the height of the head; the circlet of spines on the ovipositor; the long more or less cylindrical abdomen; the elongated cervical and prothoracic region; and the distinctive venation. The anterior intercalary vein (M_2) is continuous or nearly so with the fourth vein (Media), the last section of which (M1) curves forward, closing or greatly narrowing the distal portion of the first posterior cell (R_5) and thus greatly elongating the third posterior cell (2nd M_2) along the margin of the wing.

About one hundred species are described, most of which occur in South and Central Africa, Madagascar, India, Ceylon, China, the Malay States, and certain of the East Indies. Four or possibly three species (the rank of one as a species i.e., *pollens* O.S. has been questioned by Back,[2] and Hine[3]) occur in North America and one species has been recorded from Brazil.

The genus is notable in that it contains the largest asilid known. The species are moreover large or at least above the average size for the family. The large species referred to is one described in the present paper as *magnum*, an individual which measures 56 mm. in length, exclusive of the proboscis. In actual bulk, however, it is probably surpassed by large individuals of *Blepharotes coriarius* Wiedemann of Australia. In length, the *Blepharotes* is considerably less, the largest individual in the American Museum of Natural History measuring 48 mm., including the proboscis.

[1] Dipt. Exot., I, 2, p. 26.

[2] Trans. Amer. Ent. Soc., XXXV, p. 215, 1909.

[3] Occ. Papers, Mus. Zool. Univ. Mich., No. 61, p. 2, 1918.

The island of Madagascar is the habitat of several striking species of this genus. A collection of eighteen specimens from this island, kindly loaned the writer by the Academy of Natural Sciences of Philadelphia, was found to contain seven undescribed species. Descriptions of the latter are presented in this paper; in addition, the species of this genus already described from Madagascar are reviewed.

All specimens in the collection studied were collected by Mr. C. H. Lamberton in the forest around Tananarive, May, 1925. All types and other specimens, except as noted are in the Academy's collection.

The writer wishes to thank Mr. E. T. Cresson, Jr., of the Academy of Natural Sciences of Philadelphia, for the loan of the specimens for study and for the perusal and criticism of the manuscript. I am also greatly indebted to Dr. F. E. Lutz of the American Museum of Natural History and to others of the Museum staff particularly the librarians for the help given in obtaining literature.

List of the Species Recorded from Madagascar

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gigas Wiedemann, Dipt. Exot, p. 216, tab. 2, fig. 7, 1821; Aussereurop. Zweifl. Ins., I, p. 369, tab. 6, fig. 3, 1828 (*Dasypogon*); Macquart, Suit. a Buffon, I, p. 300, 1834, (*Dasypogon*); Dipt. Exot., Suppl. 4, p. 61, 1849; Walker,

List. Dipt. Brit. Mus. VI, Suppl. 2, p. 434, 1854 (*Dasypogon*); Bigot, Annal. Soc. Entom. France, (3), III, p. 244, 1859; Loew, Dipt-Fauna Südafr. I, p. 71, 1860; Schiner, Verh. Zool-Bot. Ges. Wein, XVI, p. 676, 1866; Kertesz, Cat. Dipt., IV, p. 152, 1909.

appendiculatum Macquart, Dipt. Exot; Suppl. 2, p. 33, 1847; Walker, List Dipt. Brit. Mus., VI. Suppl. 2, p. 468, 1854 (*Dasypogon*); Bigot, Annal. Soc. Entom. France, (3), III, p. 423, 1859; Loew, Dipt-Fauna Südafr. I, p. 71, 1860; Kertesz, Cat. Dipt., IV, p. 150, 1909.

Key to the Species

As Karsch has noted[4] the species fall naturally into two groups (1) those with a chitinous process at the ventral apex of the meso-tibia in place of the usual tibial spurs (conf. *Mimoscolia* Enderlein[5]) and (2) those with two or more spurs at the ventral apex of the meso-tibia.

1. Meso-tibia with a heavy chitinous process ventro-apically . 2.
   Meso-tibia with two or more spurs ventro-apically . . . . . 4.
2. Dorsum of abdomen reddish-chestnut in color . . . . . *cilipes*.
   Dorsum of abdomen black . . . . . 3.
3. Sides of abdomen with white spots . . . . . *hildebrandti*.
   Sides of abdomen entirely black . . . . . *radamae*.
4. First 3 abdominal segments yellow with concolorous hairs. *pulchrum*.
   First 3 abdominal segments otherwise . . . . . 5.
5. Abdomen projecting decidedly beyond tips of wings, folded back . . . . . 6.
   Abdomen reaching tips of wings or shorter than wings at rest . . . . . 7.
6. Very large reddish species (50–56 mm. in length) . . *magnum*.
   Smaller, grayish species (35 mm. in length) . . . . . *griseum* ♀.
7. Hind tarsi and tibiae of equal length . . . . . 8.
   Hind tarsi decidedly shorter than hind tibiae . . . . . 10.
8. Dorsum of thorax light yellowish with black markings. *insigne* ♀.
   Dorsum of thorax without distinct markings . . . . . 9.
9. Large black species with reddish occipital and ventral hairs (44 mm. in length) . . . . . *nigrum* ♀.
   Reddish species (about 37 mm. in length) . . . . *gladiator* ♀.
10. Mystax and tarsi reddish . . . . . *rubigenis*.
    Mystax and tarsi black . . . . . *nigritarse* ♀.

[5] Wien. Ent. Zeitschr. 33, p. 168. 1914.

[4] Berlin. Entom. Zeitschr. XXVIII, 172. 1884.

Descriptions

Unfortunately the four following species recorded from Madagascar have not been seen by the writer, hence their positions in the key can not be ascertained. *Rabodae* Karsch, however, comes under the second grouping i.e. those having spurs at the ventral tip of the meso-tibia.

Microstylum appendiculatum Macquart.

"Thorace rubido, fusco vittato, abdomine nigro, incisuris lateribusque albis, alis griseis." Length, 7 lines (14 mm.).

Microstylum gigas (Wiedemann).

♂. "Thoraca fuscano, abdomine nigro; segmentis mediis, incisuris lateribusque subtestaceis. Alis fusco-lituralis." Length, 13½ lines (28 mm.). ♀. "Abdomen entierement noir, luisant, a legers reflets verts."

Microstylum barbarossa (Wiedemann).

♂. "niger; barba rufa; alis fuscis ad costam rubidis." Length, 12 lines (24 mm.). ♀. Mystax black. Length, 19 lines (38 mm.).

Microstylum rabodae Karsch.

"Endsporn der Mittelschienen bedornt. Endsporn mit nur zwei apicalen dornen besetzt, Gleichsam an der Spitze gespalten; Leibesfarbe scahwarz, am hinterleibe glanzend; Flügel gelb." Length, 25 mm.

The species in the collection studied are as follows:

Microstylum cilipes Macquart

Four females of this large and striking species, 34–38 mm. in length, exclusive of the proboscis.

Microstylum radamae Karsch

One female. This robust black species (37 mm. in length, exclusive of proboscis) is remarkable in the great length of the proboscis. That of the specimen before me measures 8 mm. in length, which is the longest of any asilid that I have examined.

Microstylum nigrum Bigot.

One female, I take to be this species. Length, 44 mm. exclusive of proboscis. The specimen agrees with Bigot's description, except that the coxal hairs, the hairs in front of the halteres, and the hairs on the first four ventral segments of the abdomen are reddish, in addition to those of the beard and occiput. The mystax and palpal hairs are black. Rest of body deep black, except the pulvilli and bases of the ungues which are orange and the halteres which are dull testaceous.

Microstylum pulchrum new species

Length, ♂, 34 mm., ♀, 38 mm. (exclusive of rostrum which is 4 mm. in length). Robust species with dark colored wings as long as or slightly longer than abdomen. Antennae black with black hairs. Frons with golden pubescence. Vertex black with black hairs. Occiput with golden pubescence and light reddish-golden hairs. Beard golden. Mystax, palpi, and distal hairs of the palpi black. Basal hairs of palpi golden.

Thorax dark velvety brown. ♀ darker, nearly black. Prothorax with black hairs above and coarse light reddish golden hairs below. Coxae with golden hairs and a few black ones intermingled. Patch of hairs in front of halteres, reddish brown. Dorsum of thorax including scutellum with short black hairs. Posterior margin of scutellum with several black bristles. Legs black with black bristles and hairs; ungues black, pulvilli dark yellowish. First three segments of abdomen yellow with yellow hairs. Remainder dark velvety brown with yellow hairs below. ♂ genitalia very dark brown with reddish golden hairs. Ovipositor with black spines.

Holotype.—♂; [A. N. S. P. No. 6323]. *Allotopotype.*—♀.

Microstylum magnum new species

Length, 50 to 56 mm. (exclusive of rostrum which is 6–6½ mm.). Very large, elongate species, reddish in color. Thorax duller in color than legs and abdomen. Mystax, palpal hairs, beard, bristles of occiput, thorax, femorae and tibiae bright straw-colored. Frons straw-colored, slightly darker than mystax. Sides of thorax and abdomen with an inconspicuous whitish pruinosity. 4 reddish spines on posterior of scutellum. Tarsi with reddish bristles and occasional black spine. Wings dark brown, reddish along the anterior margin and in the region of the arculus. Ungues with black tips and brown bases, pulvilli light reddish. Abdomen brick red, projecting beyond tips of wings at rest. Male terminalia brown with reddish hairs. Ovipositor with dark brown spines. Hind tibia and tarsus of about equal length.

Holotype.—♂; [A. N. S. P. No. 6324]. *Allotopotype.*—♀. *Paratopotypes.*—1♂, 1♀; in the authors collection.

Microstylum gladiator new species

Length, 37–38 mm. An elongate reddish species with wings extending to the tip of the abdomen. Similar in coloration to *magnum* but is smaller and less robust. The beard, mystax and palpal hairs are nearly white. All the hairs and bristles are considerably lighter than are those of *magnum*. The whitish pruinosity of the sides of the thorax and abdomen is more conspicuous and extends onto the dorsum of the thorax further.

The wings are smoky, the veins are reddish, and the posterior margins of the wings and the margins of the veins are hyaline. There are two white spines on the posterior margin of the scutellum.

Holotype.— ♀ ; [A. N. S. P. No. 6325]. *Paratopotype.*— ♀ ; in author's collection.

Microstylum giseum new species

Length, 35 mm. (exclusive of rostrum which is 4 mm.). An elongate species, the abdomen projecting at least two segments beyond the tips of the wings. Black, with grayish-white pruinosity along sides of thorax and abdomen. Mystax white, frons with whitish pubescence. Palpi with white hairs, a few black bristles interspersed. Beard white. Occipital hairs white. Antennae black with black hairs. Ocellar tubercle black with black hairs.

Thorax black except humeral callus which is dark reddish. Pleurae and coxae with whitish hairs and pruinosity. Hairs and bristles of dorsum black. Ground color black with grayish pruinosity along sides and in depressions, setting off the dark median lines and spots. Scutellum with 2 long black bristles on posterior margin. Wings nearly hyaline. Veins dark brown except costa which is black. Legs black with black hairs and bristles. Ungues black, pulvilli dark brown. Abdomen black with black bristles on the ovipositor. Sides and venter with grayish bloom.

Holotype.— ♀ ; [A. N. S. P. No. 6326].

Microstylum insigne new species

Length, 24 mm. (except rostrum which is 3 mm.). Scarcely robust, wings extending to tip of abdomen. Antennae, antennal hairs of occiput and vertex, black. Palpi black with light hairs and one or two black bristles. Mystax straw-colored with a few black bristles. Frons with yellowish pruinosity.

Dorsum of thorax with two median longitudinal black lines and a very narrow line of yellow pruinosity between; two black lateral spots. Two black lines on each pleuron extending ventrad from in front of the base of the wing; the posterior line extends to the suture dividing the anespisternum from the sternopleurite, the anterior to the procoxa. The rest of the thorax is covered with a light yellowish bloom. Coxal hairs yellowish. Legs black with black hairs and bristles; pulvilli yellow. Wings brown. Dorsal first 4 segments of the abdomen brick red except anterior margin of first segment which is black. The fifth has some red anteriorly and along the sides; the remaining segments shining black. Ovipositor black with blackish spines.

Holotype.— ♀ ; [A. N. S. P. No. 6327].

Microstylum rubigenis new species

Length, 30 mm. (exclusive of rostrum which is 3mm.). Rather robust, wings noticeably longer than abdomen. Dull reddish with dorsum of abdomen shining black. Wings light reddish. Antennae reddish. Rostrum black. Mystax, palpal hairs, hairs of occiput and pruinosity of frons straw-colored inclining to reddish.

Prothorax dark brown, rest of thorax and legs reddish. Coxal hairs straw-colored; hairs and bristles of legs reddish with numerous short black spines on tarsi. Under side of front femora with row of short black spines. Ungues black with reddish bases. Pulvilli same color as tarsus. Bristles of posterior portion of thorax dark reddish. A patch of lighter colored hairs in front of the halteres. Dorsum of abdomen shining black with 8th segment red. Ovipositor dark reddish with black spines.

Holotype.— ♀ ; [A. N. S. P. No. 6328].

Microstylum nigritarse new species

Length, 25 mm. (exclusive of rostrum which is 2.75 mm.). Rather robust, wings projecting beyond tip of abdomen. Dark species with light reddish wings. Mystax, palpal hairs, palpi, antennae, rostrum, hairs of vertex and occiput black. Beard golden. Frons with light yellowish pruinosity. Thoracic dorsum dark brown. Femorae, tibiae dark reddish. Tarsi black. Hairs and bristles of legs and thorax black. Pleurae and prothorax black. Venter with light hairs. Abdomen: dorsum black with last two segments red; venter with fine light colored hairs. First four ventral segments with whitish pubescence.

Holotype.— ♀ ; [A. N. S. P. No. 6329].

SOME NEW SIPHONAPTERA

BY CARROLL FOX, Surgeon

United States Public Health Service

CARTERETTA[1] new genus

A Fracticipite flea; related to *Ctenophthalmus* and *Phalacropsylla*. Only the male known.

Frontal notch prominent; eye vestigial; frons with two rows of bristles the lower row of four bristles; gena with three spines on the ventral border, the first spine overlapped by the second; occiput with two oblique rows of bristles; a close set row of short hairs along posterior border of antennal groove; antennal groove open behind; labial palpi of five segments, the last segment with out the terminal hook-like bristle as seen in *Ctenophthalmus*.

Pronotum with comb. Abdominal tergites II to VII with two rows of bristles; on some of the abdominal segments the apical spinelets are distinctly lateral, reaching to within one-third the distance of the stigmatic openings; abdominal sternites with one row of bristles; antepygidial bristles three; eighth abdominal stigma inconspicuous; pygidium not convex.

Inner side of hind coxa with some thin bristles below and anteriorly, no row or patch of spinelets; bristles on posterior border of tibia in groups of three as in Phalacropsylla; fifth hind tarsal segment with three pairs of lateral plantar bristles and a ventral pair in between the first lateral pair (in the type there are on one leg three lateral bristles on one side and four on the other); fifth fore and mid tarsal segments with four pairs of lateral plantar bristles and a ventral pair in between the first lateral pair. Claspers with two processes; finger long and club like.

Genotype:—*Carteretta carteri.*

Carteretta carteri new species

There are five bristles in the anterior frontal row. Labial palpi extend to about two-thirds of the anterior coxae. There are two oblique rows of bristles on the occiput. The anterior row contains four bristles and the posterior row five on each side. The sub-marginal row contains about twelve bristles on the two sides taken together, but on each side in the type specimen the lower three bristles are missing.

[1] This generic name is proposed under authority of Article 8k International Code, as a nominative, singular, feminine substantive, formed by an arbitrary combination of letters, and the genus is dedicated to Dr. Henry R. Carter.

Pronotum has one row of about ten bristles and a ctenidium of fifteen spines. The mesonotum has a posterior row of long bristles and numerous small ones anteriorly, more or less regularly arranged in four or five rows. The metanotum has two rows of about eleven or twelve bristles and a third anteriorly of several bristles dorsally placed. The metepimerum has seven or eight bristles (3 : 3 : 1 or 4 : 3 : 1).

There are spinelets on the abdominal tergites as follows: I, 8: II, 9; III, 8; IV, 6; (all lateral) V, 5; on the abdominal tergites, two of the bristles in the posterior row are placed below the stigmatic opening. Abdominal sternites three to seven have a row of six or seven bristles each; the eighth sternite has four or five bristles on each side more widely spaced than those on the other sternites. The hind femur has a row of three bristles on the inner side and a row of seven bristles on the outer side. The outer side of the hind tibia has about twelve bristles not plainly in rows. In the posterior border of the hind tibia there are seven notches all but the upper two with bristles in groups of three. The longest apical bristle on the second hind tarsal segment reaches nearly to the apex of the fourth segment.

The two processes of the claspers are separated by a wide shallow sinus. The finger of the claspers is long, slender, and clubbed at the end where there are two bristles, one heavier than the other. The manubrium is slightly curved upwards and tapers to a narrow end. The distal half of the ninth sternite has four or five bristles towards the tip and one large bristle and a hair at about the middle. Length 2.4 mm.

Host:—*Neotoma fuscipes* from Los Angeles, California, 1925.

Type.—♂. U. S. National Museum collection. Cat. No. 40353.

Ceratophyllus francisi new species

Eye present. Of the three bristles in the posterior genal row the middle is the smallest and is placed closer to and slightly above the inner bristle; the anterior row is represented by one bristle placed near the anterior margin of head and one placed at edge of antennal groove; the labial palpi extend to the trochanters; there is one bristle back of the antennal groove about the middle; in the female some of the hairs on the 2nd antennal segment are longer than the club.

The pronotal comb consists of seventeen or eighteen spines; the metathoracic epimerum carries three bristles.

The hind femur carries a row of nine bristles on the inner side and two bristles on the outer side; the hind tibia has a row of four bristles on the inner side and four on the outer side;

some of the bristles on the posterior border of the hind tibia are unusually long and the longest of the apical bristles is more than twice as long as the tibia is broad at apex; one of the apical bristles on the second hind tarsal segment extends to the tip or even beyond the fifth segment; the five pairs of lateral plantar bristles on the fifth tarsal segment of all legs are in line.

The style is twice as long as wide at base. The body of the spermatheca is shortened in its antero-posterior diameter.

The finger of the claspers reaches almost to the tip of the process, it is straight on its dorsal border and convex in its ventral border. It has towards its base two relatively short, heavy bristles, on dorsal edge. The ninth sternite bears two bristles near the sinus and further towards the base two flat, pointed modified bristles. The eighth abdominal segment of the male is quite hairy. Length: male, 1.7 mm.; female 2.0 mm.

Host:—*Citellus mollis*. Collected by Dr. Edward Francis in Utah, 1920.

Type.—♂. U. S. National Museum collection. Cat. No. 40354.

Ceratophyllus bertholfi new species

Eye present. The middle bristle of the posterior genal row is the smallest, the anterior row is represented in the female by a bristle at the anterior edge of the antennal groove, in the male by two bristles near the edge of the antennal groove and one at the anterior edge of the head; back of he antennal groove are two bristles; the hairs on the 2nd antennal segment are about as long as the club; the labial palpi extend well beyond the trochanters.

The pronotal ctenidium consists of about eighteen spines. The abdominal sternites carry two rows of bristles a posterior row of about ten stout bristles and an anterior row of fewer, more slender ones; the eighth tergite in the female has a group of four or five bristles just beneath the pygidium. In the male there are three long bristles at the tip of the eighth sternite which is somewhat prolonged caudad; there are no lateral hairs on second abdominal sternite. The style is more than twice as long as wide and contains at its tip a stout bristle as well as several finer ones. Antipygideal bristles, male, one (and a small hair), female three, on each side.

The hind femur has on its outer surface but three bristles and on its inner surface a row of about twelve or fourteen bristles; the longest apical bristle on the second segment of hind tarsus reaches to or almost to the end of the fourth segment; all lateral bristles on fifth tarsal segment are in line.

The process of the claspers is rather broad and evenly rounded. It contains at the tip a group of hairs. The finger is broadest at about the middle. It is nearly three times as long as broad. Its ventral border is convex and contains about eight bristles equally spaced, with one longer and stouter one near the tip. The dorsal border is angled. The finger of this species reminds one of the finger of *Ceratophyllus fasciatus* but it is heavier. The tip extends slightly above the process. The manubrium is decidedly curved towards the tip. Length: male 2.2 mm.; female 2.9 mm.

Host.—*Citellus nebulicola* from Nagai Island, Alaska. 1909.

Type.—♂. U. S. National Museum collection. Cat. No. 40355.

ON NEW AND CERTAIN PREVIOUSLY-KNOWN AMERICAN GENERA OF THE ACRIDINAE, WITH SPECIFIC COMMENTS AND DESCRIPTIONS

(ORTHOPTERA, ACRIDIDAE)

BY JAMES A. G. REHN

In endeavoring to ascertain the relationship and the true position of the North American species which have been associated under the generic names *Psoloessa* and *Stirapleura*, I have been compelled to examine critically the related genera, as well as those species from Central and South America which have been referred to *Stirapleura*. The results of my work on the North American forms, as well as on the species correctly associated from Mexico, will appear later in a monographic study. It seems desirable, however, to present the results of my examination of the related genera, even though these are by no means comprehensive or detailed, as a number of important facts on the relationship of the genera involved have been ascertained, and several new genera and certain new species must be described to present intelligently the information secured.

The North American genera associated in the usual classifications at the end of the subfamily Acridinae (Truxalinae of many authors) toward the Oedipodinae, are a rather motley assemblage. The difficulty of satisfactorily drawing a line between these two subfamilies, which typically are so different, is the major reason for the generally unsatisfactory character of this association. Certain workers endeavored to better the situation by removing the genus *Aulocara* to the Oedipodinae, but this is hardly logical unless much more than typical *Aulocara* is so moved. To remove those genera which are really associated in a natural grouping brings into question characters which are essentially truxaline, and the situation is more unnatural and illogical than to permit true *Aulocara* to remain in the Acridinae. There can be no question, however, but that *Heliaula* Caudell, based on Scudder's *Aulocara rufum*, is truly an oedipodine genus, as Caudell affirms,[1] and it is in no way related to true *Aulocara*.

[1] Proc. U. S. Nat. Mus., XLIX, p. 27, (1915).

The Group Aulocari

A few words in historical retrospect regarding the genera here discussed, may be of interest. Brunner, in his classical "Révision" of 1893,[2] used two genera groups to include the North American genera there placed after the "Stenobothri" in his linear arrangement. These were, (1) the Scyllinae, including *Scyllina*, *Boöpedon* and his *Coloradella;* (2) the Epacromiae, in which, with other genera, he placed *Mecostethus* Fieber (= *Stethophyma* Fischer as now restricted). The first of these groupings is a natural assemblage centering about *Scyllina*, and including a number of genera, while the second as used by him is a very unnatural association, as the genera *Epacromia* (= *Aiolopus*), *Chortoicetes* and *Stethophyma* represent two very distinct stocks. McNeill, in his "Revision of the Truxalinae of North America," made no effort to group the genera, and his linear arrangement bristles with incongruities in its wide separation of certain related genera. Scudder, in 1900, in his "Catalogue" places in the group Scyllinae the genera *Boöpedon*, *Plectrotettix* (= *Scyllina*), *Eupnigodes*, *Psoloessa*, *Stirapleura*, *Ageneotettix* and *Aulocara*, while with *Mecostethus* (= *Stethophyma*) he associates *Ligurotettix* in the impossible Epacromiae. In 1904, in the "Biologia Centrali-Americana,"[3] Bruner follows the same group and generic arrangement, except to add his new genus *Zapata* to the Scyllinae between *Eupnigodes* and *Psoloessa*, and the new *Goniatron* in the vicinity of *Ligurotettix*.

The present author in 1923, when studying the genera *Ligurotettix* and *Goniatron*,[4] found it necessary to remove them from the vicinity of the genera with which they had been associated, and to erect a group Ligurotettigi to include them. At the same time it was evident that the group was related on one hand to an assemblage embracing *Ageneotettix*, *Aulocara*, *Eupnigodes*, *Psoloessa* and *Stirapleura*, there called the Stirapleuri, and on the other to one including *Mecostethus* (= *Stethophyma*), *Pallasiella* and *Arcyptera*, for which the name Mecostethi (or now more properly Stethophymati) was then used. Emphasis was there placed on the fact that *Ligurotettix* and *Goniatron* have no affinity in any way with the true Epacromiae (or Aiolopi as it

[2] Ann. Mus. Civ. Stor. Nat. Genova, (2), XIII, p. 123, (1893).

[3] Biol. Cent.-Amer., Orth., II, pp. 32–34, 112–113.

[4] Trans. Amer. Entom. Soc., XLIX, pp. 43–45.

now must be called), the latter group as restricted not occurring in America.

The present broader survey of these genera fully supports the general conclusions reached in 1923, but as would be expected it is now possible to speak with more assurance regarding certain affinities. At the previous writing I did not feel fully confident of the homogenous character of the assemblage first mentioned, i. e. that containing *Ageneotettix*, *Aulocara*, *Eupnigodes*, *Psoloessa* and *Stirapleura*. It is now evident that two distinct stocks are there represented; one for which I would use the group name Aulocari, including *Ageneotettix*, *Eupnigodes*, *Zapata*, *Drepanopterna* and *Zapata;* the other, which I would call the group Psoloessae, containing the North American species which have been referred to *Psoloessa* and *Stirapleura*.

There can be little question of the fundamental distinctness of the *Psoloessae*,[5] as the group possesses a sum total of features very clearly separating it from the other assemblage. The fastigial form, the type and disposition of the lateral foveolae, the pronotal form and constriction collectively separate the group from the less homogenous Aulocari.

As to the phylogenetic relationship of the genera of the Aulocari, it would seem that *Ageneotettix* more nearly approaches the Scyllinae than any of the other genera, with *Eupnigodes* a modified offshoot of the *Ageneotettix* stock. The genus *Drepanopterna*, described in the present paper, occupies a position relatively remote from *Ageneotettix*, with *Zapata* either a highly modified development from the same or the representation of a related stock. The extreme development of the phylum is clearly represented by *Aulocara*. In consequence the linear arrangement which seems most logical is the following: *Ageneotettix*, *Eupnigodes*, *Zapata*, *Drepanopterna* and *Aulocara*. The exact position of *Zapata* and *Drepanopterna* may be debatable, and a reversal of the positions here given the two might well be argued, but the weight of evidence would seem to be in favor of the above linear arrangement. There can be no question of the relatively isolated position of *Aulocara*, although there is

[5] This name is used advisedly instead of the previously proposed Stirapleuri, the reasons for which will be apparent after examination of my forthcoming monographic study.

much in common with *Drepanopterna*. The unusual form of the distal abdominal sternite (subgenital plate) of the female in the latter genus is one of its distinctive and unusual features. The pronotal form in *Drepanopterna* is another character of definite value, for while *Eupnigodes* has the general structure and proportions of this somewhat similar, the disparity in length of the prozona and metazona is greater in *Drepanopterna*. In addition the sculpturing of the pronotal lateral lobes is quite different in the two genera. In many respects *Zapata* holds a unique position, but in others it is closely related, and certain features virtually parallel those of *Ageneotettix*. The disparity in length of the caudal tibial spurs in the latter genus as compared with *Zapata* is, however, a marked feature of difference. This feature is one which would throw *Zapata* and *Aulocara* together and relatively isolate *Drepanopterna*, yet the fastigial form and that of the frontal costa have little in common in the two genera, and in both of these features *Drepanopterna* and *Aulocara* have very similar developments.

It will be evident from these few comments that an idea of relationship in these genera can be secured only from the sum total of characters, and the arrangement given here is based on an analysis of a number of features in all the genera considered.

ZAPATA Bruner

1904. *Zapata* Bruner, Biol. Cent.-Amer., Orth., II, pp. 33, 103.

Genotype.—Zapata brevipennis Bruner.

When describing this genus, and the genotypic species, Bruner felt considerable doubt as to whether the male and female specimens before him were specifically identical. His comment (p. 103) was: "It is barely possible that these two insects belong to different species and to different genera as well. If this should prove to be the case, the male might readily be referred to the genus *Aulocara*, where it could bear the same specific name. The female insect is the one that has been kept in mind as the type of the genus *Zapata*." Some few pages beyond (p. 111), in treating the genus *Aulocara*, Bruner concluded that the imperfect male did not represent the genus *Zapata*, and he redescribed it as a species of *Aulocara*. This removed the male from consideration in connection with *Zapata*,

the original basis of which is thus narrowed down to the female specimen to which *Zapata brevipennis* is limited. Bruner's *Aulocara brevipenne* is in all probability a species of the new genus *Drepanopterna.*

The type female of *Zapata brevipennis* Bruner is contained in the Hebard Collection, and is now before me. A related but distinct new species from Mexico is in hand, and an extensive series of another from southern Arizona attests the presence of the genus in the United States.

Distribution of the species of the genus *Zapata.*

The generic description given by Bruner not being sufficiently broad to include the present new species, and also including features of the erroneously included male, I am giving a new diagnosis embracing characters found in the three species before me.

Generic Description.—Form relative robust, weakly compressed in the male sex. Head sub-bullate to bullate, particularly

across genae; fastigium appreciably transverse to slightly longitudinal, shallowly concave excavate, cephalic margins forming an acute angle in male, acute-angulate to rectangulate in female, lateral margins weakly convergent caudad or subparallel; lateral foveolae small, acute lanceolate, weakly or obsoletely impressed, ventral margin of same often obsolete; frontal costa broad to very broad, slightly expanding ventrad of median ocellus, lateral margins of costa there subobsolete, surface of costa non-sulcate. Pronotum short and broad, subcompressed in male sex, weakly strangulate mesad; no lateral carinae present on disk; median carina indicated but very weak on prozona, more evident on metazona; prozona slightly longer than metazona; cephalic margin of pronotal disk weakly convex, caudal margin of same broadly rounded obtuse-angulate, ranging from a nearly subtruncate to a distinctly produced condition; disk broadly rounding into lateral lobes with but a slightly indicated shoulder on metazona: lateral lobes of pronotum subquadrate to slightly deeper than long. Tegmina abbreviate, ovate, narrowly attingent or overlapping mesad, but faintly longer than pronotal disk, or fully developed and reaching to or falling but slightly short of apex of abdomen. Wings vestigial or fully developed and reaching to tegminal apices. Interspace between mesosternal lobes decidedly transverse; interspace between metasternal lobes slightly transverse to quadrate in female, narrow and longitudinal in male. Distal abdominal sternite of female (subgenital plate) with distal margin narrowly rectangulate produced mesad; laterad bisigmoidal convergent to same. Cerci of male simple, styliform, tapering. Subgenital plate of male subconical. Caudal tibiae with internal calcaria relatively short, moderately and regularly arcuate in distal half, that on flexor side slightly longer than the other, neither more than two-thirds as long as metatarsus. External margin of caudal tibiae with eight to nine spines.

The three species known to me may be separated by the following key:

A. Brachypterous, at least in female sex; tegmina not more than one and one-third times length of dorsum of pronotum. Fastigio-facial angle in profile broadly rounded. Pronotum proportionately shorter and broader; median carina weaker; caudal margin of pronotal disk very slightly obtuse-angulate, hardly at all produced, and almost weak arcuate in outline.

B. Head and pronotum moderately inflated; frontal costa proportionately narrower. Eyes proportionately larger. Fastigium narrowly longitudinal (♀), its cephalic angle acute. Lateral lobes of pronotum with greatest length and depth subequal.....*Z. brevipennis* Bruner

B.B. Head and pronotum more decidedly inflated; frontal costa proportionately broader. Eyes proportionately smaller. Fastigium broad (♀), the excavate area alone markedly transverse, its cephalic angle rectangulate. Lateral lobes of pronotum with greatest depth appreciably surpassing greatest length.....*Z. bucculenta* new species

A.A. Macropterous in both sexes; tegmina reaching to or falling but slightly short of apex of abdomen. Fastigio-facial angle in profile subangulate, narrowly rounded. Pronotum proportionately longer and narrower; median carina more pronounced; caudal margin of pronotal disk distinctly obtuse-angulate produced.
Z. salutator new species

Zapata brevipennis Bruner (Pl. XXII, figs. 1–3.)

1904. *Zapata brevipennis* Bruner, Biol. Cent.-Amer., Orth., II, p. 103, pl. 1, figs. 22 and 22a. [♀ (not ♂); Lerdo, Durango, Mexico, (not Camacho, Zacatecas, Mexico).]

This species is known only from the unique type, which lacks one antenna and the right caudal limb.

Zapata bucculenta[5] new species (Pl. XXII, figs. 4 and 5.)

Closely related to *Z. brevipennis*, but at once distinguishable by the features given in the above key. The inflated character of the head and pronotum is very evident, and the broad, much blunter fastigium and decidedly widened frontal costa are very distinctive. Probably *bucculenta* replaces *brevipennis* in the more elevated territory about Durango.

Type.— ♀; Durango, State of Durango, Mexico. November 27, 1909. (F. C. Bishopp.) [United States National Museum.]

Size relatively small (much the same as in *Z. brevipennis*); form robust, head and pronotum appreciably inflated, brachypterous.

Head with greatest width across eyes four-fifths that across genae. Fastigium broad, short, in general appearance blunt, excavate portion distinctly transverse, shallowly concave, cephalic margin rectangulate; lateral foveolae poorly indicated, longitudinal, little impressed, ventral margin subobsolete. Frontal costa broad, between antennal bases five-eighths as wide as fastigium, narrowing from that point dorsad, lateral margins of costa subparallel thence to below median ocellus,

[5] In allusion to the broad head, with its full genae.

thence ventrad subobsolete and diverging; surface of frontal costa sparsely punctate, non-sulcate. Eyes relatively small, appreciably bullate, dorso-ventral length faintly shorter than infra-ocular sulcus, outline of eye as seen in profile very broad ovoid, apex ventrad, cephalic portion of margin distinctly flattened and weakly arcuate.

Pronotum short and broad, full, dorsum of prozona weakly but appreciably subinflated, greatest length of pronotal disk subequal to width caudad across metazona; cephalic margin of disk arcuato-truncate, caudal margin hardly produced, arcuate subobtuse-angulate; median carina subobsolete on prozona, distinct but low and delicate on metazona; prozona occupying three-fifths of pronotal length: lateral lobes of pronotum with greatest depth of same distinctly greater than dorsal length of same (as 9 to 7), the lobes narrowing ventrad, ventral margin obtuse-angulate.

Tegmina about one and one-third times as long as pronotal disk, ovate, rounded distad, broadly overlapping in distal half of the sutural margin; venation as in *Z. brevipennis.*

Interspace between mesosternal lobes strongly transverse, internal margins of the lobes obliquely arcuate; metasternal interspace slightly transverse. Ovipositor jaws short, ventral pair relatively broad. Distal margin of distal abdominal tergite (subgenital plate) narrowly rectangulate produced mesad, laterad converging sigmoid.

Cephalic and median limbs very short. Caudal femora stocky, relatively robust, reaching to apex of abdomen; caudal tibiae with nine spines on external margin, internal spurs faintly more elongate than in *Z. brevipennis,* difference in length not pronounced, proximal portion of same straight, the falcation entirely distad; caudal metatarsus comprising slightly more than half of entire tarsal length.

General color of dorsal surface pale ferruginous, passing laterad into light ochraceous-salmon, with the ventral surface dull amber yellow. Head and pronotum obscurely sprinkled and mottled with hazel, dorsum of metazona with a transversely disposed contrasted blotch of chestnut-brown, the cephalic outline of which is bi-concavely obtuse-angulate, the blotch involving the caudal margin laterad but not mesad. Eyes dresden brown mottled with mummy brown. Dorsal surface of abdomen washed with dresden brown and thickly sprinkled with mummy brown; ovipositor jaws edged with mummy brown. Cephalic and median limbs of the dorsal color, subannulate with cinnamon brown to mummy brown. Caudal femora of the general color, darker above, paler below, trifasciate with mummy brown on dorsal surface, external pagina lightly tinted with dull slate-olive; caudal tibiae coral red becoming buffy and obscurely

mottled with brownish proximad, spines black tipped; caudal tarsi buffy, washed above with coral red.

Length of body, 18.5 mm.; length of pronotum, 3.4; greatest width of pronotal disk, 3.3; length of tegmen, 4.5; greatest width of tegmen, 2.9; length of caudal femur, 10.6.

The type of this species is unique.

Zapata salutator new species (Pl. xxii figs. 6–9.)

Differing from *Z. brevipennis* and *bucculenta* in the features given in the above key. On account of the fully developed alar organs and the different shape of the pronotum, the general appearance of *salutator* is different from that of the other species, while the fastigial profile is an added feature of diagnostic value. When the male sexes of *brevipennis* and *bucculenta* are known possibly other characters of value will be found.

Type.— ♀ ; Tumamoc Hill, Tucson Mountains, Pima County, Arizona. Elevation, 2400–3092 feet. October 3–4, 1910. (Hebard and Rehn.) [Hebard Collection, Type no. 1110.]

Size medium; form relatively robust, alate.

Head in cephalic aspect but moderately inflated across genae, the width across eyes four-fifths that across genae: fastigium with the shallowly concave excavation of subequal length and breadth, cephalic margin of same slightly acute-angulate with immediate angle subtruncate; lateral foveolae longitudinal, narrow lanceolate, appreciably impressed but poorly defined; fastigio-facial angle in profile narrowly rounded obtuse-angulate; frontal costa broad, regularly but gradually widening ventrad from inter-antennal section, surface punctate but non-sulcate. Eyes moderately prominent, in lateral outline with cephalic portion of same distinctly deplanato-arcuate, dorso-cephalic and ventral points relatively sharp, dorso-ventral length of eye slightly greater than length of infra-ocular sulcus. Antennae slender, over twice as long as dorsum of pronotum, joints elongate.

Pronotum relatively robust, weakly but appreciably strangulate: dorsal surface with cephalic margin moderately convex, appreciably produced; caudal margin of same rounded broad obtuse-angulate with immediate angle transversely blunted: median carina distinct over entire disk, more elevated on metazona, where it is also more finely cut; prozona occupying seven-twelfths of entire length of pronotal disk, principal transverse sulcus deeply impressed; lateral shoulders on metazona evident but broadly rounded. Lateral lobes of pronotum slightly

deeper than dorsal length, roughly subquadrate in proportions but weakly narrowing ventrad, ventral margin of lobes broadly obtuse-angulate; surface of lobes appreciably impressed mesoventrad.

Tegmina reaching to the caudal femoral apices and falling faintly short of the apex of the abdomen, coriaceous; venation normal, intercalated field with a false intercalary vein forming a double row of irregular cells. Wings equalling tegmina in length.

Interspace between mesosternal lobes strongly transverse, the width equal to twice the length of the interspace; metasternal interspace distinctly but narrowly transverse. Ovipositor jaws normal; distal abdominal sternite (subgenital plate) broadly obtuse-angulate distad with the faintest possible indication of a median production.

Caudal femora slightly more elongate and slender than in the other species of the genus, its greatest depth contained within a small fraction of four times in its length, tibial spurs nearly subequal in length; caudal tibiae with nine spines on external margin.

Allotype.—♂; same data as type. [Hebard Collection.]

Differing from the above description of the male sex (type) in the following noteworthy features:

Size smaller; form more compressed.

Head in cephalic aspect but weakly inflated across genae, width across eyes almost subequal to that across genae: fastigium with excavation longitudinal, its greatest width contained one and one-half times in length of same, cephalic margin of same sharply acute with apex broadly blunted; frontal costa narrower, but faintly expanding ventrad from fastigio-facial angle to median ocellus, then ventrad with its subobsolete margins more decidedly expanding. Eyes prominent, in lateral outline more ovate, cephalic section of outline more strongly arcuate, dorso-cephalic and ventral angles more broadly rounded. Antennae three times as long as dorsum of pronotum.

Pronotum appreciably narrower and more compressed, no more strangulate than in female.

Tegmina surpassing apex of abdomen by nearly the length of the pronotal disk, not surpassing the femoral apices.

Interspace between mesosternal lobes transverse but less strongly so than in female, the width equal to but faintly more than the length of the interspace; metasternal interspace narrow, longitudinal. Cerci subcompressed, simple, styliform, tapering, acute. Subgenital plate (distal abdominal sternite) little produced in profile, its dorsal and distal outline rectangulate in same view, from dorsum dorsal sections of plate are seen to be subcompressed, from venter extremity of plate is blunted acute-angulate.

General base color variable, ranging from as light as pale ecru-drab and drab-gray to as dark as tawny and russet. Two general types of color pattern are predominatingly evident, one (a) showing no pronounced body marking except a transverse broad, cephalad obtuse-angulate dark maculation on the metazonal disk of the pronotum; the other (b) shows a distinct medio-longitudinal pale bar extending from the tip of the fastigium to the distal section of the anal field of the tegmina. These two types are probably genetic and between them we find numerous intermediate stages, in certain of which the pale medio-longitudinal pale line divides the dark metazonal marking into two parts. In a few individuals neither type is evident. The following comments are supplementary to those above given. Face and genae ranging from uniformly pale grayish white, with or without scattered bluish mottlings, through cinnamon-buff to the latter with the genae, postocular regions and occiput washed with russet; eyes tawny and ochraceous-tawny to russet; antennae of the head color proximad, becoming mummy brown distad. Pronotum in a very few specimens unmarked, pale ferruginous, faintly darkened obliquely across the lateral lobes; pale medio-longitudinal bar, when present, ranging from light ochraceous-buff to dull zinc orange, bordered laterad to a variable degree with mummy brown clouding, more pronounced cephalad and caudad, the latter section being generally part of the divided metazona dark area as found in the color type above called "b"; metazonal dark blotch, when present, mummy brown to bister in color, variable in intensity and extent, rarely reaching caudal margin of the disk mesad, and then in less intensity than along the latero-cephalic sections of the patch, which are always the more pronounced when the maculation is present. In typically developed type "b" individuals the lateral lobes of the pronotum are obscurely marked with darker mummy brown to bister. Tegmina in type "a" typically with scattered small maculations of mummy brown to bister, but the number and intensity of these markings vary, and in type "b" these are greatly reduced or almost absent, while the anal field is there pale, as it forms part of the pale medio-longitudinal bar. Caudal femora ranging from pale salmon-buff to cinnamon-rufous, external pagina and distal section of ventro-lateral face generally infuscate to a variable degree with prout's brown to mummy brown, dorsal surface trifasciate with same, the proximal fasciation weak; caudal tibiae light coral red to dragon's-blood red, becoming buffy proximad, spines and spurs tipped with mummy brown to bister; caudal tarsi pinkish buff.

Measurements (in millimeters)

♂	Length of body	Length of pronotum	Length of tegmen	Greatest length of caudal femur
Tumamoc Hill, Arizona	13	2.6	9	8.8
Tumamoc Hill, Arizona, *allotype*	14	2.8	10.8	10
Roeble's Pass, Arizona	14.5	2.5	8	8.2
Roeble's Pass, Arizona	14.5	2.7	10.6	9
Schaeffer Canyon Wash, Arizona	11.4	2.1	8.4	7.5
Komalik, Arizona	11.9	2	7.5	—
Komalik, Arizona	12.2	2.1	8.5	8
Ajo, Arizona	11.2	2.3	8.5	7.9
♀				
Tumamoc Hill, Arizona	20.5	3.5	13.	11.3
Tumamoc Hill, Arizona, *type*	22.6	3.9	14.8	13
Tumamoc Hill, Arizona	22.4	4.1	15.4	13.4
Roeble's Pass, Arizona	17.9	3.3	11.3	10.9
Roeble's Pass, Arizona	20.4	3.6	13	12.5
Komalik, Arizona	16	2.7	9.1	9
Komalik, Arizona	18.1	3.3	11.2	11
Ajo, Arizona	18.4	3.3	11.1	11.2
Ajo, Arizona	22.4	3.6	13.8	12.3

In addition to the type and allotype I have before me an extensive series, all the adult individuals of which can be considered paratypes. The data for these representations, all contained in the Hebard Collection and that of the Academy, are as follows:

Tumamoc Hill, Tucson Mountains, Pima County, Arizona, elevation 2,400–3,092 feet. October 3–4, 1910. (Hebard and Rehn; common in short dry yellow grass growing among rocks.) Twenty-two males, twenty-five females.

Roeble's Pass, Tucson Mountains, Pima County, Arizona, elevation about 3000 feet. October 11, 1910. (Hebard and Rehn; quite plentiful in low grass among bushes.) Seven males, ten females.

Roadside Mine, near north base of Coyote Mountains, Pima County, Arizona, elevation 2800 feet. September 14, 1924. (Hebard and Rehn; few on grassy gravelly "draw" dotted with palo verde and mesquite.) Two males, one female.

Wash of Schaeffer Canyon, east side of Baboquivari Mountains, Pima County, Arizona, elevation 4500 feet. September 20, 1924. (Hebard and Rehn; on low gravelly rolling ridges with short grass and mimosaceous bushes.) One male.

Hendrick's Canyon, west side of Baboquivari Mountains, Pima County, Arizona, elevation 3200 feet. September 14,

1924. (Hebard and Rehn; on granite slopes of canyon among sahuaro, ocotillo and other vegetation.) One male, one immature male, one immature female.

Fortification Rock, Baboquivari Valley, Pima County, Arizona, elevation 2900–3300 feet. September 14, 1924. (Hebard and Rehn.) One female.

Komalik, Baboquivari Valley, Pima County, Arizona, elevation 2550 feet. September 14, 1924. (Hebard and Rehn; occasional on granitic hillside with scant grass and characteristic shrubbery.) Ten males, four females.

Road Pass, Artesa Mountains, Pima County, Arizona, elevation 2650 feet. September 15, 1924. (Hebard and Rehn.) One male.

Quitojoa Mountains between Covered Wells and Pozo Blanco, Pima County, Arizona, elevation 2750 feet. September 17, 1924. (Hebard and Rehn; scarce on sparsely grassed slopes among rocks.) One male.

Little Ajo Mountains near Ajo, Pima County, Arizona, elevation 1800 feet. September 18, 1922. (Hebard and Rehn; in moderate numbers on gravelly and rock strewn slopes with sparse short yellow grass, and about the scattered palo verde, ironwood, sahuaro and creosote bush making up the arborescent cover.) Six males, fourteen females.

The above notes show that the species is locally distributed over that portion of the Mexican border country of Arizona which lies between the Tucson region and the Ajo district, probably extending but little north of the two sections mentioned. This range corresponds very clearly with a definitely recognizable faunula within the United States, typified by a number of species. Within this territory *Z. salutator* occurs in its preferred habitat, which is an environment of sparse, rather scattered short grass, usually sun-cured and yellow when *Zapata* is mature, and generally with its attendant rich desert shrubbery of sahuaro, ocotillo, palo verde, ironwood and creosote bush. East of the Tucson district this striking arborescent desert vegetation, at least in its greatest development and diversity, soon disappears, while west of the Ajo section the increasing sterility and more marked desert conditions greatly restrict or prevent the development of the same vegetational complex.

An examination of the series shows that, as evidenced by the above measurements, the Tucson and Little Ajo Mountains series apparently represent the optimum size development of

the species. This is quite in keeping with the relative richness of the vegetation of the environment. The Komalik series, on the other hand, shows considerable size reduction. This may be due to the very restricted extent of the preferred habitat at that locality, a few low hills surrounded by broad and relatively low wash plains dotted with mesquite, the latter environment foreign to the species before us.

The color features show clearly two phases, probably genetic, and marked variation in the general tonal depth, which latter may have some environmental association. Of the series of sufficient size to make deductions of value, the Komalik representation shows the palest general color and the greatest suppression of maculations. The Tumamoc Hill and Little Ajo Mountains lots show marked diversity in tone and pattern, but their tendency is decidedly toward a deep, richly colored phase.

DREPANOPTERNA[6] new genus

(Pl. XXII, figs. 10–13.)

1899. *Aulocara* Scudder, Proc. Amer. Acad. Arts and Sciences, xxxv, No. 2, pp. 54, 55. (In part.)

The species selected as genotype of this genus, which latter with due regard for consistency must be named and characterized, has been referred to *Aulocara* by all authors since its description by Scudder in 1899. The systematic position of the genus has been discussed above, and the generic features, as drawn from the genotype, are here given.

Generic Characters.—Head large proportionately; fastigium with cephalic angle acute, excavate cephalad, no median carina, lateral borders distinctly carinate; fastigio-facial angle broadly rounded; face distinctly (♂) to slightly (♀) retreating: frontal costa narrow dorsad and regularly widening ventrad in male, moderately excavato-sulcate dorsad of median ocellus and briefly and shallowly so for a short distance ventrad of same; in female broad and subequal except for narrowing dorsad at fastigio-facial angle, deplanate, non-sulcate: lateral foveolae distinct, decurved, lanceolate, broadly so in female, variable in excavation, ventral margin of foveolae obsolete to subobsolete by variation. Eyes ovate, large and prominent in male, less evident and proportionately smaller in female. Antennae filiform, distinctly exceeding head and pronotum in length.

[6] From δρεπάνη *sickle*, and πτερνα *heel*, in allusion to the calcaria of the caudal tibiae.

Pronotum compressed particularly in male, distinctly strangulate in both sexes; median carina distinct; lateral carinae almost unindicated structurally, distinctly clepsydral pale markings indicating their usual position; prozona exceeding metazona in length, occupying from three-fifths (male) to five-eighths (female) of entire length of disk; principal transverse sulcus deeply impressed; surface of metazona distinctly but not deeply cribroso-punctulate; caudal margin of pronotal disk arcuately obtuse-angulate. Lateral lobes of pronotum deeper than long. Tegmina rarely reaching apex of abdomen, lanceolate, apex narrowly rounded; longitudinal veins markedly evident, pronounced intercalary vein present. Interspace between mesosternal lobes transverse in both sexes, internal margin of lobes broadly arcuate; interspace between metasternal lobes narrowly longitudinal in male, subquadrate in female. Male cerci simple, styliform, acute. Distal abdominal sternite (subgenital plate) of male compressed, cup-shaped, rounded distad. Ovipositor jaws of female short, deep, heavy, dorso-lateral margin of dorsal pair appreciably arcuato-sublamellate before the recurved apical hook, dorsal surface of same excavate mesad; ventral surface of ventral valves with an analogous structure of smaller size preceding apical hook: distal abdominal sternite (subgenital plate) with its distal margin deeply cut by two V-shaped emarginations in which lie the ventral ovipositor jaws, the intervening section being an acute production between the valves, while the caudo-lateral sections of the plate are developed into projecting vertical subcompressed lamellations, which distad are rectangulate and obliquely truncate dorsad as seen in lateral aspect. Limbs slender, cephalic and median pair particularly so; caudal femora reaching to or distinctly surpassing apex of abdomen; caudal tibiae with external margin having nine to eleven spines, internal calcaria markedly unequal in length, both strongly falcate distad, that in flexor position nearly twice as long as that in extensor position and equal to at least five-eighths of metatarsal length, its proximal two-thirds straight, while the other has no more than its proximal half straight.

Genotype.—Aulocara femoratum Scudder.

To this genus is also tentatively referred *Aulocara brevipenne* Bruner,[7] the unique male type of which is now before me. It is quite distinct from the type of *Zapata brevipennis* Bruner, a unique female now in hand, discussed in preceding pages, and with which Bruner[8] felt the male later called an *Aulocara*

[7] 1905. Biol. Cent.-Amer., Orth., II, p. 111. [♂; Comacho (nec Comancho), Zacatecas, Mexico.]

[8] 1904. Biol. Cent.-Amer., Orth., II, p. 103.

might be associated. The type of *Aulocara brevipenne* is in very poor condition, and it is exceedingly difficult definitely to determine its true relationship to *femoratum*, but this is undoubtedly close, although nothing is known of the features of the female sex, which are quite distinctive in *femoratum*.

Certain South American Genera Referable to the Group Scyllinae

SCYLLINOPS new genus

1851. *Oedipoda* Blanchard, in Gay, Hist. Fis. y Polit. de Chile, Zool., VI, p. 79. [In part.] (Not *Oedipoda* Serville, 1831.)
1900. *Stirapleura* Bruner, Second Rep. Merchants' Loc. Invest. Comm., pp. 23, 33. (Not *Stirapleura* Scudder, 1876.)
1905. *Stirapleura* Bruner, Biol. Cent.-Amer., Orth., II, p. 105. [In part.]
1906. *Stirapleura* Rehn, Proc. Acad. Nat. Sci. Phila., 1906, p. 49. (Not *Stirapleura* Scudder, 1876.)

Genotype.—Stirapleura bruneri Rehn (= *Stirapleura signatipennis* Bruner [not *Oedipoda signatipennis* Blanchard]).

The logical position of this genus is in the Group Scyllinae near *Scyllina* Stål and *Euplectrotettix* Bruner. The broader pronotum and less elongate form will distinguish *Scyllinops* from both of these genera. The more dorsal lateral foveolae, decussate pronotal disk and less deplanate lateral lobes of the pronotum are additional features of difference from *Euplectrotettix*, while the more impressed and generally rhomboid lateral foveolae, the more deplanate and not transversely arcuate frontal costa, which is also narrower dorsad, the more prominent eyes (except in *S. signatipennis*) and the subequal prozona and metazona of the pronotal disk further distinguish *Scyllinops* from *Scyllina*. As *Scyllina* shows several lines of development which in their extreme conditions are very different in general appearance, I have used for comparison the more typical stock represented by the genotype *S. cyanipes* (Fabricius), of which Stål's *Scyllina peragrans* is a synonym. It is possible that the species *signatipennis* and *humilis* (Blanchard), here tentatively placed in *Scyllinops*, may require removal from that genus. They clearly show affinity with true *Scyllina*, but the latter genus, as understood to-day, is so heterogeneous that until its components have been restudied in the light of present-day knowledge of variation in the group, it would seem best to do no more than state the tendencies seen. There is an ensemble

to the species referred to *Scyllina* which is clearly recognizable but most difficult to put in words, a certain "trimness" even evident in the more robust species. The genotype of *Scyllinops* (*S. bruneri*), and the other species here definitely referred to the same genus, form a cohesive assemblage, with evident features of difference from *Scyllina*.

Generic Characters.—Alate; moderately robust. Head with fastigial disk excavate, transverse or subequal, angulate cephalad: lateral foveolae fossulate, trapezoidal rhomboid, visible in their entirety from dorsal surface: fastigio-facial angle in profile narrowly rounded, face moderately declivent: frontal costa transversely subdeplanate, narrowing dorsad. Pronotum relatively short and robust, particularly in female; lateral carinae of disk clepsydral, occasionally subobsolete; median carina evident; caudal margin angulate; prozona and metazona of disk subequal in length; as a whole the pronotum is weakly strangulate. Tegmina reaching at least to apex of abdomen; no true intercalary vein present;[9] ulnar area hardly if at all wider than intercalary area. Ovipositor jaws of female normal. Distal abdominal sternite of female with its caudal margin triundulate, having a median and paired lateral extensions between and around ventral ovipositor jaws. Caudal tibial spurs markedly unequal in length, the longer distinctly falcate and moderately recurved at apex.

I have before me material of seven species, five definitely and two provisionally referable to this genus, all having been placed by recent authors in the genus *Stirapleura*, which, however, in its true sense occurs only in North America and Mexico. Five of the species here considered are represented in the series before me by type or paratypic material; of the remaining two I feel certain of their identity. Taken with *Stirapleura brunnea* Rehn, which is here discussed on page 238 under *Pellopedon*, and the properly associated *Stirapleura brachyptera* Bruner, these species embrace all the South and Central American species associated under *Stirapleura*, which have been recognized by recent workers.

While the definitely referred species show a distinct tendency to break into two species-group, the line of cleavage, however, is not defined with sufficient sharpness to warrant the segregation

[9] A fortuitous or false intercalary vein is occasionally indicated, but a well marked and continuous vein is not present in the species studied.

or arrangement of the forms into two assemblages. The most logical linear arrangement of the species here associated appears to me to be as follows:

Scyllinops bruneri (Rehn)

1900. *S[tirapleura] signatipennis* Bruner, Second Rep. Merch. Locust Invest. Comm., p. 34. [♂, ♀; Pampa Central of Argentina to Uruguay.] (Not *Oedipoda signatipennis* Blanchard, 1851.)

1906. *Stirapleura bruneri* Rehn, Proc. Acad. Nat. Sci. Phila., 1906, p. 49. [♂, ♀; Carcaraña, Argentina.]

Type and allotype examined.

Scyllinops pallida (Bruner)

1900. *S[tirapleura] pallida* Bruner, Second Rep. Merch. Locust Invest. Comm., pp. 34, 35, fig. 11. [♂, ♀; Carcaraña and other portions of Sante Fé and Buenos Aires Provinces, Argentina.]

Paratypic male and female examined.

Scyllinops salina (Bruner)

1905. *Stirapleura salina* Bruner, Biol. Cent.-Amer., Orth., II, pp. 106, 107. [♀; Salina Cruz, Mexico.]

1905. *Stirapleura meridionalis* Bruner, Biol. Cent.-Amer., Orth., II, pp. 106, 107. [♂, ♀; Salina Cruz, Mexico.]

Type and paratype of *S. salina* and type and allotype of *S. meridionalis* examined.

Scyllinops variabilis (Bruner)

1900. *S[tirapleura] variabilis* Bruner, Second Rep. Merch. Locust Invest. Comm. pp. 34, 36, fig. 12. [♂, ♀; Bahia Blanca and Pampa Central, Argentina.]

Paratypic male and female examined.

Scyllinops obscura (Bruner)

1900. *S[tirapleura] obscura* Bruner, Second Rep. Merch. Locust Invest. Comm., pp. 34, 36. [♂, ♀; Bahia Blanca, Argentina.]

Paratypic male and female examined.

Provisionally referred species (vide supra).

Scyllinops humilis (Blanchard)

1851. *Oedipoda humilis* Blanchard, in Gay, Hist. Fis. y Polit. de Chile, Zool., VI, p. 50. [Coquimbo, Chile.]

1906. *Stirapleura humilis* Rehn, Proc. Acad. Nat. Sci. Phila., 1906, p. 50. [♂, ♀; Penco, Concepcion, Longuen, Guiltio and Lota, Chile.]

Scyllinops signatipennis (Blanchard)

1851 *Oedipoda signatipennis* Blanchard, in Gay, Hist. Fis. y Polit. de Chile Zool., VI, p. 79. [Coquimbo, Chile.]

1906. *Stirapleura signatipennis* Rehn, Proc. Acad. Nat. Sci. Phila., 1906, p. 49. [♀; Penco and Concepcion, Chile.[10]]

There can be no question of the synonymy of *Stirapleura salina* and *S. meridionalis*, as they represent merely color phases of the same species, the former based on more uniformly colored individuals, the latter on contrastingly patterned material. No structural feature worthy of note is apparent, and the color differences are essentially as found in the same species in other members of this and related genera.

It is quite possible that the examination of extensive series, and a quantitative study of the features given below, at least provisionally, as specific, may necessitate some modification of our present understanding of the distinctness of *S. bruneri* and *pallida*, and *S. variabilis* and *obscura*. These pairs of species are very closely related and each lot is from the same general region. The limited amount of available material of three of these forms, and its inconclusive character, prevents at this time any real attempt to go more deeply into the situation.

I have commented above on the tendencies toward *Scyllina* exhibited by the two species which are provisionally referred to *Scyllinops*. No matter what disposition is finally made of them generically, they represent the line through which differentiation has progressed, regardless of whether *Scyllina* or *Scyllinops* is the more ancient and ancestral type. Personally I feel *Scyllina* is the more primitive assemblage, largely on account of the marked divergence of its phyla, but other factors have been considered in this connection, and in endeavoring to trace the evolution of these genera.

Tentative Key to the Species of the Genus Scyllinops

A. Distal abdominal sternite (subgenital plate) of female with its disto-lateral margin developed into a brief but distinct acute peg-like process. (Size medium: ♀, length of body, 20–21 mm.; length of caudal femur, 13.5–14.9. General color relatively uniform brownish or rufous, or

[10] The record of a single male from Coronel, Chile as *S. humilis* is an error, as that individual represents the male sex of *S. signatipennis*.

buffy with mummy brown maculations, in the latter contrasted phase with a decided ventro-cephalad directed arcuate dark dash sweeping across the lobe. Tegmina without a pale longitudinal line on costal side of humeral trunk. Frontal costa proportionately narrow.) (Southern Mexico.) ..... *salina* (Bruner)

AA. Distal abdominal sternite (subgenital plate) of female with its disto-lateral margin never developed into an acute peg-like process.

B. Lateral lobes of pronotum with cephalic and caudal margins regularly and decidedly converging ventrad.

C. Distal abdominal sternite (subgenital plate) of female with its inter-valvar production decided and acute, disto-lateral sections of segments distinctly broad arcuate produced.

D. Lateral carinae of pronotal disk well indicated both in structure and color, subobsolete only narrowly mesad. Disk of pronotum and dorsal section of lateral lobes of same contrasted in coloration..... (Argentina.) *bruneri* (Rehn)

DD. Lateral carinae of pronotal disk subobsolete in structure, particularly mesad and caudad, not at all indicated by color features. Disk of pronotum and dorsal section of lateral lobes of same unicolorous.. (Argentina.) *pallida* (Bruner)

CC. Distal abdominal sternite (subgenital plate) of female with its inter-valvar production shorter, not acute, disto-lateral sections of segment not broadly arcuate produced.

D. Size larger (length of body, ♂, 14.2 mm.; ♀ 23–27: length of caudal femur, ♂, 9.5 mm.; ♀, 15–16.8. Eyes slightly narrower in lateral aspect; in profile the infra-ocular sulcus is equal to (♂) or distinctly longer than half depth of eye (♀). Caudal femora proportionately more slender..... (Chile.) *signatipennis* (Blanchard)

DD. Size smaller (length of body, ♂, 10–12.2 mm.; ♀, 12–14.5: length of caudal femur ♂, 7.5–9 mm.; ♀, 8.9–10.5).[11] Eyes slightly broader in lateral aspect; in profile the infraocular sulcus in distinctly less than (♂) or hardly if at all

[11] I find that in some unaccountable way the maximum size measurement of total length (i. e. over all including the tegmina) of the female sex of *humilis* given by me in 1906 (Proc. Acad. Nat. Sci. Phila., 1906, p. 50) is decidedly too great. This was stated to be 20 millimeters, but probably this is a typographical error for 16, which would be the correct figure.

longer than half depth of eye (♀). Caudal femora proportionately more robust.
(Chile.) *humilis* (Blanchard)

BB. Lateral lobes of pronotum with cephalic and caudal margins sub-parallel, not converging ventrad.

C. Form somewhat more robust, particularly in female sex. General coloration of the usual scyllinoid type of lineations and blotches, often with appreciable greenish washes over the pale base color.
(Bahia Blanca, Argentina.) *variabilis* (Bruner)

CC. Form somewhat less robust, particularly in female sex. General coloration dull, more suffused, no pronounced scyllinoid pattern, pale areas largely limited to face, ventral portion of lateral lobes of pronotum and limbs, particularly in male sex; no greenish wash present. (Bahia Blanca, Argentina.)
obscura (Bruner)

MELOSCIRTUS Bruner

1906. *Meloscirtus* Bruner, Proc. U. S. Nat. Mus., xxx, pp. 622, 634.

This genus, based on *M. australis* Bruner, from Sapucay, Paraguay, was originally stated to be "related to *Stenobothrus* and *Bruneria*, but differing from both of these genera in a number of respects." I have seen no material of the genotype, but in 1913 Bruner described a second species as *M. montanus*,[12] of which both sexes are now before me. The descriptions of *Meloscirtus* and of *M. australis* give little help as to the proper position of the genus, except that it is evident certain of the features cited are more those of the scyllinoid genera than of the gomphoceroid ones given as allies. The specimens of *M. montanus* now in hand, and one of them is a paratypic female from Bruner's original series, show conclusively that, at least on the evidence of *Meloscirtus montanus*, the genus is a specialized member of the Scyllinae, its nearest relationship probably with *Scyllina*. The species *montanus* has many of the peculiarities of high montane and alpine forms, i. e. robust build, heavy integument which is coarsely punctate and rugulose in certain areas, and reduced alar appendages. The latter feature, however, is shared with the lowland *M. australis*. The internal caudal tibial spurs are distinctly unequal, as generally considered

[12] Proc. U. S. Nat. Mus., xliv, p. 178. [♀; Cuzco, Peru.]

characteristic of the Scyllinae, while the fastigial form, the face, eye position, general limb structure, apex of the male abdomen and of the ovipositor jaws, and of the distal abdominal sternite of the female all show the scyllinoid relationship.

Meloscirtus montanus Bruner

1913. *Meloscirtus montanus* Bruner, Proc. U. S. Nat. Mus., XLIV, p. 178. [♀; Cuzco, Peru, 11,500 feet elevation.]

Cuzco, Peru, 11,500 feet. July, 1911. (Yale Peruvian Expedition.) 1 ♀ paratype. [Hebard Cln.]

Oroya, Peru, 12,178 feet. June 21, 1914. (H. S. Parish.) 2 ♂, 1 ♀. [A.N.S.P.]

As the male sex has never been described, I have selected one of the above males as the allotype, and here give its salient features.

Description of Allotype.—Size medium; form medium, brachypterous.

Head with fastigium from dorsum slightly acute-angulate, weakly impressed within its margins, transversely delimited caudad on line with cephalic point of eyes, a faint medio-longitudinal carinula present on fastigium and most of occiput; lateral foveolae elongate rhomboid, deeply impressed, entirely visible from dorsum: in profile fastigio-facial angle is narrowly rounded, facial outline gently arcuate between antennal bases, thence distinctly retreating ventrad; frontal costa of moderate width, slightly widening ventrad, subequal briefly between antennal bases and median ocellus, punctate with remainder of face, and very briefly sulcate about median ocellus. Eyes but moderately prominent, in basal outline acute subovoid, more deplanate cephalad, their dorso-ventral dimension but slightly less than twice length of infra-ocular sulcus. Antennae but slightly shorter than combined length of head and pronotum, relatively robust, appreciably deplanate, articles quadrate to subtransverse.

Pronotum not at all strangulate, most of surface of lateral lobes subparallel as seen from dorsum, dorsal section of lateral lobes broadly rounded to the disk: cephalic margin of disk subtruncate, caudal margin weakly arcuato-angulate, faintly flattened mesad: median carina distinct and broad but low; lateral carinae of disk as distinct as median carina, but appreciably constricted and subobsolete briefly cephalad of middle of disk; prozona about one and one-fourth times the length of metazona. Lateral lobes of pronotum with their greatest dorsal length subequal to their depth, cephalic and caudal margins moderately converging, ventral margin weakly obtuse-angulate. Metazona of disk and lateral lobes distinctly ruguloso-punctate.

Tegmina slightly less than twice as long as pronotum, apex narrowly rounded, anal field relatively broad, major venation well and typically developed.

Mesonotum with interspace between lobes faintly transverse, metasternal lobes narrowly separated caudad. Abdomen with apex somewhat elevated but not recurved; virtually no furcula indicated; supra-anal plate broad, proximal width subequal to median length, lateral margins moderately converging to distal third, then sharply and sigmoidly bisarcuate to the rectangulate apex, which has its margin somewhat elevated, general surface of plate elsewhere subdeplanate, intermarginally subexcavate. Cerci simple, styliform, compressed, tapering sublamellate in lateral view, distal section faintly decurved. Subgenital plate produced into a distinct subapical tubercle, which, however, is in no way cut off by contour from the remainder of the plate's surface, seen in profile the dorsal margins of the plate are weakly convex, from the dorsum they converge distad, meeting at the apex of an acute fissation; ventral surface of subgenital plate proximo-mesad with a distinct indentation, which in a narrowing fashion extends toward apex of plate, the indentation also involving the adjacent medio-distal portion of the preceding sternite.

Cephalic and median limbs short, femora very robust and appreciably bullate. Caudal femora moderately robust, extending distinctly but not greatly caudad of the abdominal apex: caudal tibiae slightly shorter than the femora, armed on external margin with nine or ten spines, internal with eleven spines; internal tibial spurs with the shorter about three-fourths as long as the other, both arcuate, the shorter more regularly so, neither sharply falcate distad, the longer equal to one-half the length of caudal metatarsus. Caudal tarsi slightly less than half as long as caudal tibiae, metatarsus comprising one-half of tarsal length.

General base color of dorsum in both sexes light brownish olive to brownish olive, indefinite but appreciable paired longitudinal bister bars, intersected by the pale lateral carinae, present laterad on disk and dorsad on lateral lobes of pronotum, weakly continued cephalad over occiput as a pair of arcuate lines; venter of thorax and abdomen and much of cephalic and median limbs mustard yellow to dark wax yellow. Head occasionally with an indefinite bister postocular bar; eyes buckthorn brown to snuff brown; antennae burnt umber, paler toward lateral margins of articles. Lateral carinae of pronotum honey yellow in female, dull isabelline in male: lateral lobes of pronotum with a very faint (♂) or appreciable (♀) honey yellow tendency ventrad. Tegmina mummy brown, darker

proximad and with principal veins pencilled with blackish; area between mediastine vein and humeral trunk almost entirely lineate with ochraceous-buff to flesh-ocher. Dorsum of abdomen dark citrine (♂) to citrine (♀), laterad clouded with dark olive (♂) to blackish (♀), in the latter more sharply defined and contrasted. Cephalic and median limbs, largely as a wash over yellow on the femora, mars brown. Caudal limbs basically russet to mars brown in the male, in the female the femora with a dull yellowish base color over-laid on dorsal half with an obscure trifasciation of russet, ventral femoral faces russet with lineation of yellowish between; tibiae and tarsi russet, spines and spurs black tipped.

Measurements (in millimeters)

	Length of body	Length of pronotum	Length of tegmen	Greatest length of caudal femur
♂, Oroya, Peru, *allotype*...	15.6	3.2	6.	9.3
♂, " "	16.2	3.4	6.1	9.6
♀, " "	23.6	4.2	7.2	13.2
♀, Cuzco, Peru, *paratype*..	21.[13]	4.5	7.8	13.1

PELLOPEDON Bruner

1906. *Stirapleura* Rehn, Proc. U. S. Nat. Mus., xxx, p. 390. (Not *Stirapleura* Scudder, 1876.)

1911. *Pellopedon* Bruner, Ann. Carneg. Mus., viii, p. 37.

This generic name was introduced by Bruner in commenting on *Stirapleura brunnea* Rehn,[14] as follows, "I had placed this insect aside under the manuscript name *Pellopedon obscurum.*" As this combination is definitely associated with *Stirapleura brunnea*, following my personal opinion and that of numerous colleagues on the situation, I am utilizing *Pellopedon* Bruner with the genotype *P. obscurum* Bruner (= *Stirapleura brunnea* Rehn), for the genus which must be characterized to include the species *brunnea.*

An analysis of the features of this genus shows conclusively that it must be removed from the vicinity of the other South American species which have been referred to *Stirapleura*, and also that it is not at all closely related to the latter genus in its proper sense (genotype *S. decussata* Scudder).

The genus *Pellopedon* apparently occupies an isolated position, largely on account of the peculiar build of the pronotum,

[13] Distinctly shrivelled.

[14] Proc. U. S. Nat. Mus., xxx, p. 390, (1906).

the heavy fastigium and frontal costa, the character of the integument of the face, lateral lobes of the pronotum and pleura, and the nearly subequal internal caudal tibial spurs. The general form of the lateral lobes of the pronotum suggests *Isonyx* Rehn,[15] but the fastigial form and numerous other features are markedly different, and show that real affinity with *Isonyx* cannot be claimed. Bruner[16] states that *Stirapleura brunnea* is "rather closely related generally" to *Stereotettix* Rehn.[17] This is pure assumption, as the genera *Pellopedon* and *Stereotettix* have very little in common, and the merest examination of the two will show they cannot be associated, even as genera of the same group.

That *Pellopedon* is an aberrant scyllinoid is the most logical position to take, but to ascertain its true position in a linear arrangement will require a thorough revision of the scyllinoid genera, which lack of time will not permit me to make at present.

Generic Characters:—Form moderately robust, fully alate; surface of face, frontal costa, lower border of genae, pronotum and pleura cribroso-punctate. Face arcuate declivent; fastigio-facial angle in profile distinct, rounded obtuse in male, more broadly rounded in female: fastigium broad, blunt, transverse; excavation transverse, sharply rectangulate (male) to arcuate-rectangulate (female) in cephalic outline; caudal section of fastigium, interocular region and occiput with medio-longitudinal carinula: lateral foveolae visible from dorsum, punctate impressed in roughly ovate area: frontal costa broad, continuous, weakly expanding ventrad, weakly sulcate at median ocellus. Pronotal disk with marked and regular median carina; lateral carinae distinctly indicated cephalad on prozona as weakly caudad converging ridges, and as diverging ones on metazona, less evident on caudal half of prozona; prozona slightly longer than metazona; caudal margin of pronotal disk obtuse-angulate produced. Lateral lobes of pronotum distinctly deeper than long; cephalic and caudal margins slightly but regularly converging ventrad, ventral margin marked sigmoid arcuate-emarginate cephalad and strongly arcuate caudad; ventro-cephalic angle marked and subrectangulate, ventro-caudal angle broadly rounded in female, the ventral margin regularly passing

[15] Proc. Acad. Nat. Sci. Phila., 1906, p. 36. (Genotype.—*Isonyx paraguayensis* Rehn.)

[16] Vide supra.

[17] Proc. U. S. Nat. Mus., xxx, p. 381, (1906).

into caudal margin, in male evident as weak obtuse-angulation. Tegmina and wings surpassing apex of abdomen by at least length of pronotal disk, former subcoriaceous in texture. Interspace between mesosternal lobes weakly transverse in both sexes; metasternal lobes contiguous (male) or subcontiguous (female) caudad. Ovipositor jaws of female of normal type. Distal abdominal tergite briefly but acutely produced between bases of ventral pair of ovipositor jaws. Internal caudal tibial spurs little unequal in length, flexor one slightly the longer, both subfalcate but regularly narrowing; external tibial margin with nine spines: caudal metatarsus nearly equal in length to remainder of tarsus.

Pellopedon brunneum (Rehn)

1906. *Stirapleura brunnea* Rehn, Proc. U. S. Nat. Mus., xxx, p. 390. [♂, ♀; Chapada, Matto Grosso, Brazil.]
1911. *Pellopedon obscurum* Brunner, Ann. Carneg., Mus., viii, p. 37.

Relative to Bruner's comments[18] on the difference in size of material of this species before him, from the measurements originally given by me, I have measured the paratypic specimens in the collection of the Academy, and Mr. Caudell has kindly supplied me with remeasurements of the type and allotype, and the dimensions of a paratypic female in the U. S. National Museum. These figures show that, while my original measurements of the pronotal length of the type and allotype (i. e. 3.5 mm. in male, 4.2 in female), were slightly too large, there is no reason to consider the somewhat smaller specimens measured by Bruner as a distinct species (*obscurum* Bruner). The new measurements (in millimeters) are as follows:

	Length of body	Length of pronotum	Length of tegmen	Length of caudal femur
♂				
Chapada, Brazil, *type* (U.S.N.M.)...	15	3.25	14	10
Chapada, Brazil, *paratype* (A.N.S.P.)	15	3.02	14	9.7
♀				
Chapada, Brazil, *allotype* (U.S.N.M.)	22	4	17.5	12
Chapada, Brazil, *paratype* (U.S.N.M.)	20.5	3.9	17.5	11
Chapada, Brazil, *paratype* (A.N.S.P.)	20	3.78	17.2	11.9

[18] Ann. Carneg. Mus., viii, p. 37, (1911).

Explanation of Plate XXII

Fig. 1.—*Zapata brevipennis* Bruner. Female (type). Lerdo, Durango, Mexico. Dorsal view of fastigium. (Greatly enlarged.)

Fig. 2.—*Zapata brevipennis* Bruner. Female (type). Lerdo, Durango, Mexico. Cephalic aspect of head. (× 5.)

Fig. 3.—*Zapata brevipennis* Bruner. Female (type). Lerdo, Durango, Mexico. Lateral view of fastigio-facial area. (Greatly enlarged.)

Fig. 4.—*Zapata bucculenta* new species. Female (type). Durango, Durango, Mexico. Dorsal view of fastigium. (Greatly enlarged.)

Fig. 5.—*Zapata bucculenta* new species. Female (type). Durango, Durango, Mexico. Cephalic aspect of head. (× 5.)

Fig. 6.—*Zapata salutator* new species. Female (type). Tumamoc Hill, Tucson Mts., Pima County, Arizona. Dorsal view of fastigium. (Greatly enlarged.)

Fig. 7.—*Zapata salutator* new species. Female (type). Tumamoc Hill, Tucson Mts., Pima County, Arizona. Cephalic aspect of head. (× 5.)

Fig. 8.—*Zapata salutator* new species. Female (type). Tumamoc Hill, Tucson Mts., Pima County, Arizona. Lateral view of fastigio-facial area. (Greatly enlarged.)

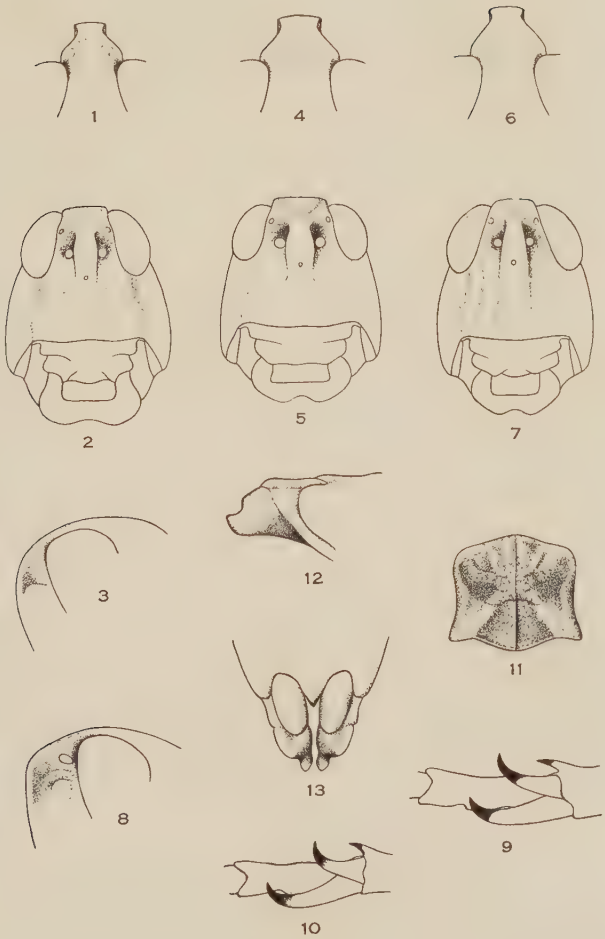
Fig. 9.—*Zapata salutator* new species. Female (type). Tumamoc Hill, Tucson Mts., Pima County, Arizona. Internal calcaria of caudal tibia. (Greatly enlarged.)

Fig. 10.—*Drepanopterna femoratum* (Scudder). Female. Glen, Sioux County, Nebraska. Internal calcaria of caudal tibia. (Greatly enlarged.)

Fig. 11.—*Drepanopterna femoratum* (Scudder). Female. Finney County, Kansas. Dorsal view of pronotum. (× 4.)

Fig. 12.—*Drepanopterna femoratum* (Scudder). Female. Finney County, Kansas. Lateral view of ovipositor jaws. (Greatly enlarged.)

Fig. 13.—*Drepanopterna femoratum* (Scudder). Female. Finney County, Kansas. Ventral view of ventral ovipositor jaws and distal abdominal sternite (subgenital plate). (Greatly enlarged.)



REHN—CERTAIN AMERICAN GENERA OF ACRIDINAE

THE NORTH AMERICAN SPECIES OF PTILODACTYLA (COLEOPTERA: HELODIDAE)

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There are at present known to the author four species of the genus *Ptilodactyla* Latr. which inhabit that portion of America which is north of the United States-Mexican boundary. Two of these have been long known; two are here described as new.

The genus is a large one. Of the more than one hundred described species over fifty come from Central America, a very few from Asia, still fewer from North America and the rest from South America and the West Indies. A brief study of the Central American specimens available indicates that but a fraction of the existing species has been described. The species make up a monotonous series of closely related and by the external anatomy almost indistinguishable forms. Definite color patterns are almost entirely lacking, all of the species being of some hue of brown. Their outline varies from broadly to narrowly elliptical. The pronotum is almost always somewhat produced in front.

In arranging the Central American species, Champion found the conformation of the scutellum to be of considerable aid; unfortunately it does not serve in our own species. He also made use of the punctation of the head and pronotum; in the North American species these parts are always granulate-punctate and never furnished with simple punctures. Only by the study of the internal genitalia and claws of the males can characters of prime importance be found, and it is astonishing what great differences are displayed in these parts in two species which cannot be separated *with certainty* in any other way. There are a few minor characters displayed on the external surface of these insects; all are comparative in nature and should at the most be used with discretion. In reference to the use of the male genitalia for taxonomic purposes, it may be noted that an examination of the extreme tips of the median and lateral lobes is all that is necessary for a determination and that the majority of specimens killed by any of the usual methods have a part of the genitalia extruded after death.

Since any dichotomous key to these species which I am able to construct would of necessity be based on the claws and genitalia, it has seemed better to figure the parts for each of the species and allow the worker to make direct comparisons.

I wish to thank Messrs. C. S. Brimley and R. W. Harned for the loan of material from North Carolina and Mississippi, respectively. I wish also to express my appreciation of the courteous attention of the staff of The Academy of Natural Sciences of Philadelphia in making it possible for me to examine the Horn collection.

Ptilodactyla serricollis (Say)

1823. *Ptilinus serricollis* Say, Journ. Acad. Nat. Sci. Phila., III, p. 186.
1880. *Ptilodactyla serricollis* Horn, Trans. Amer. Ent. Soc., VIII, p. 90, pl. 1, fig. 6.

Tarsal claws of front legs of male with inner portion of unguis short and broad, truncate at tip (Fig. 7). Pronotum granulate-punctate. Scutellum cordate, with a small notch in front and with a very poorly defined median sulcus. Color above deep to light brown, below and antennae castaneous, legs and mouth parts pale. Head finely and not densely granulate-punctate, pubescence sparse and pale. Antennae with the third segment very little shorter but conspicuously broader than the fourth, rami (male only) of all segments longer than the respective segments. Pronotum much broader than long (25:40), basal margin finely denticulate along the outer thirds, middle third with three teeth before the scutellum. Elytra with very feebly impressed striae, varying from strongly seriate punctate to simple impressed striae, finely and moderately densely punctate, reflexed portion concave, finely punctured and shining. Mesosternum carinate between the middle coxae, metasternal process between posterior coxae with short but deep impression. Abdominal sternites finely but sparsely punctured, surface finely alutaceous, terminal sternite of male with a nearly semicircular emargination at apex and with a small round depression just before the emargination, terminal sternite of female not modified.

Lateral lobes of male genitalia setiform, as long as the median lobe which is several times as thick, is evenly curved and strongly widened just before apex (Fig. 1). There is some variation in the relative length of the median lobe in the specimens examined. Length: 4–6 mm.

Type locality.—"Missouri." Specimen figured is from Pennsylvania.

Type.—Lost.

Material examined.—185 specimens from the following localities.

ALABAMA: Mobile, June 11, (H. Soltau), 1.

DISTRICT OF COLUMBIA: Washington, June 3 29, (Hubbard and Schwarz), 2. FLORIDA: Biscayne, May 21, (Hubbard and Schwarz), 1; Crescent City, (Hubbard and Schwarz), 1; Enterprise, May 15–16, (Hubbard and Schwarz), 4; Haulover, Mar. 1, (Hubbard and Schwarz), 1; Monticello, Apr. 15, (W. A. Hoffman), 1; Paradise Key, Feb. to June, (Barber, Mosier and Schwarz), 82; Sand Point, Feb. 18, (Hubbard and Schwarz), 1.

ILLINOIS: Northern part, 2 specimens.

INDIANA: New Albany, Aug. 7, (H. Soltau), 1.

KENTUCKY: Rockhaven, July 22, (H. Soltau), 1.

LOUISIANA: Crowley, Sept. 30, (E. S. Tucker), 1.

MARYLAND: Breton Bay, Potomac River, July 13, (Barber and Budlong), 1; Forest Glen, May 28–June 13, (O. Heidemann), 6; Plummer's Island, June 8–August 8, (Barber, McAtee, Schwarz and Shannon) 56.

MICHIGAN: Port Huron, June, (Hubbard and Schwarz), 2.

MISSISSIPPI: Agricultural College, May 7–18, (J. M. Langston, R. C. Hubbard, S. N. Boyd, E. Runnells, P. D. Sanders), 5.

MISSOURI: Two specimens.

NORTH CAROLINA: Raleigh, May 29–June 20, (Sherman and Woglum), 2, [in collection N. C. State Exp. Station]; Retreat, May 31, (Hubbard and Schwarz) 1; Round Knob, June 29, (Hubbard and Schwarz), 1.

OHIO: 2 specimens; Cincinnati, Aug. 19, (H. Soltau), 2.

PENNSYLVANIA: Four specimens.

SOUTH CAROLINA: Swansea, Aug. 5, (F. Knab), 1.

VIRGINIA: Rosslyn, Apr. 29–30, (R. C. Shannon; reared from larvae), 4, shed larvae skins preserved with imagos.]

Ptilodactyla angustata Horn

1880. *Ptilodactyla angustata* Horn, Trans. Amer. Ent. Soc., VIII, p. 90–91.

Tarsal claws of front legs of male with inner portion of unguis more than half as long as outer, somewhat curved, acute at tip (Fig. 6). Pronotum granulate-punctate. Scutellum cordate, with small notch in front, without median sulcus. Color above and below pale brownish testaceous, legs, antennae and mouth parts paler. Antenna with the third segment as long as the fourth, the rami (male only) slightly longer than the respective segments. Head rather coarsely granulate-punctate, sparsely pubescent, eyes large, slightly more approximate than are the sockets of the antennae. Pronotum broader than long (32:50), moderately coarsely and sparsely granulate-punctate, denticulation of basal margin almost obsolete, the three median teeth very obtuse, almost absent. Elytra obsoletely seriate-punctate, the interspaces rather finely and sparsely punctured, pubescence sparse, reflexed portion not noticeably concave, rather sparsely punctured. Mesosternum slightly concave between the middle coxae, very obsoletely carinate, metasternal process between the hind coxae with a minute impression at apex. Abdominal

sternites finely and sparsely punctured, obsoletely alutaceous, terminal sternite of male with a subtriangular apical notch, broadly and shallowly depressed along the median line. Terminal sternite of female simple, unmodified.

Lateral lobes of male genitalia acutely triangular, capable of being deflexed, the deflexion accompanying the extrusion of the median lobe (Fig. 4). There is some variation in the relative length of the lateral and median lobes in specimens examined. Length: 3.5–4.5 mm.

Type locality.—Florida. Specimen figured is from Plummer's Island, Md.

Type.—Lost.

Material examined.—72 specimens from the following localities.

District of Columbia: Washington, June 17–July 2, (Hubbard and Schwarz), 4.

Florida: Biscayne, May 12–13, (Hubbard and Schwarz), 3; Crescent City, (Hubbard and Schwarz), 2; Enterprise, May 7–June 28, (Hubbard and Schwarz), 4; Homestead, Mar. 23, (on *Zamia* species, E. A. Schwarz), 1; Paradise Key, Feb. 19–Mar. 13, (Barber and Schwarz), 24.

Kentucky: Corbin, June 29, (H. Soltau), 1; Louisville, July 17, (H. Soltau), 1.

Maryland: Breton Bay, Potomac River, July 13, (Barber and Budlong), 5; Plummer's Island, June 11–July 16, (Barber, Currie and Schwarz), 18.

North Carolina: Ashville, (B. T. Turner), 1; Retreat, June 17, (Hubbard and Schwarz), 1.

Tennessee: Memphis, May 29, (H. Soltau), 1.

Virginia: Great Falls, June 30, (A. Wetmore), 1; Lake Drummond, June 8–11, (H. S. Barber), 1; Pennington Gap, July 8, (Hubbard and Schwarz), 1; near Plummer's Island, July 23, (H. S. Barber), 1; Stone Creek, Lee Co., (Hubbard and Schwarz), 1.

In addition there is a single female specimen in the collection from Dallas, Texas, June 15, (W. A. Hooker), which I doubtfully refer to this species.

The plan of the genitalia of this species is very different from that common to the other North American species. In the first place the lateral lobes are so constructed that they may be deflected through an arc of more than 90°, and, secondly, by the deflection of the lateral lobes the median lobe is forced forward nearly half its length. The significance of these modifications is not apparent.

In the original description Dr. Horn describes the last abdominal segment as emarginate in both sexes. So far as I am aware there is no species in this genus in which the last abdominal segment of the female is other than entire. It is probable that the diagnosis of the female characters was taken from a specimen in a slightly distorted condition.

An examination of the Horn collection, preserved at the Academy of Natural Sciences of Philadelphia, reveals the surprising fact that the only specimen identified as *P. angustata* Hn. is a depauperate individual of *P. serricollis* (Say) from Florida. There can be no doubt that this is not one of the original lot since its characters are not in accord with Horn's description. That it is a specimen of *P. serricollis* (Say) is evidenced by the partially extruded genitalia. There is nothing in the original description that will permit recognition of the type specimen, whereever it may be, and it must be considered as permanently lost. As to where it came from originally, we can only surmise that it was from the extensive Florida collections of Messrs. Hubbard and Schwarz. It is known that many of the species described by Horn and Leconte were derived from this source and that, prior to 1880, this was practically the only source of Florida material. Of this species in the Hubbard and Schwarz collection there are but four specimens which antedate Horn's description. They are from Enterprise and may be part of the lot from which the species was described.

Ptilodactyla equilobata new species

Tarsal claws of front legs of male with inner portion of unguis half as long as outer, slightly curved, rounded at tip (Fig. 8). Pronotum granulate punctate. Scutellum cordate, with small notch in front, without median longitudinal sulcus. Color above and below castaneous, legs and antennae paler. Head rather closely granulate-punctate, pubescence sparse, short and pale. Antenna with the third segment slightly longer than the fourth, rami (male only) of all segments slightly longer than the respective segments. Pronotum much wider than long (25:41), strongly rounded and convex in front, hind angles nearly 90°, greatest width just in front of the base, basal margin finely denticulate with three more prominent teeth near the middle. Elytra very obsoletely seriate-punctate, reflexed portion slightly concave, sparsely punctured, shining. Mesosternum carinate between the coxae, metasternal process between posterior coxae with a small but deep impression. Abdominal sternites very finely and densely punctured, terminal sternite of male with a rather shallow notch and with a slight depression just before the notch. Terminal sternite of female simple, not modified.

Lateral lobes of male genitalia truncate at their apices, about as long and as broad as the median lobe (Fig. 3). Length: 5.5–6 mm.

Type locality.—Devils River, Tex., May 5–24, 1907, Bishopp, Pratt, and Schwarz, collectors. Specimen figured is from type locality.

Type.—The type, a male, collected May 5. The genitalia are partially extruded. *Paratypes.*—One male (partially dissected) and six females from type locality. [U. S. N. M., Cat. No. 40347.]

In addition to the type series I have before me three female specimens which I assign to this species. Two of them are from Columbus, Tex., May 25 June 17, collection of C. V. Riley). The other is from Kerrville, Tex., June 24, (F. C. Pratt).

In Champion's key,[1] this species runs out with *P. chiriquensis* Champ., from which it differs in its larger size and uniform coloration.

Ptilodactyla exotica new species

Tarsal claws of front legs of male with inner portion of unguis quadrate and less than half as long as outer (Fig. 5). Pronotum granulate-punctate. Scutellum cordate, notched in front, with out median sulcus. Color above piceous, beneath castaneous, legs and palpi pale. Head sparingly granulate-punctate, eyes large, separated by less distance than the antennae. Antenna with the third segment slightly shorter than the fourth, in the male the rami are more than half again as long as their respective segments. Pronotum much broader than long (19:30), evenly but rather sparsely granulate-punctate, broadly rounded in front, posterior angles slightly less than 90°, greatest width just before the base which is finely denticulate and with three small teeth near the middle. Elytra with but traces of striae, surface irregularly and finely granulate-punctate basally, with fine punctures apically, reflexed portion only slightly concave, shining. Mesosternum finely carinate between the middle coxae, metasternal process between the posterior coxae with short carina. Abdominal sternites very finely and densely punctured, terminal sternite of male with a small shallow notch, that of female unmodified.

Lateral lobes of male genitalia acute at their extremities, about as long as the median lobe (Fig. 2). Length: 3.5 6 mm.

Type locality.—Melrose Park, Ill., in rose greenhouse, November, 1926, C. C. Compton, collector. Specimen figured from type locality.

[1] Biologia Centr. Amer., III, pl. 1, p. 628.

Type.—Male, with the genitalia partially extruded. [U. S. N. M., Cat. No. 40348]. *Paratypes.*—115, males and females; deposited in United States National Museum (66), Museum of Comparative Zoology, American Museum of Natural History, Academy of Natural Science, Philadelphia, Illinois State Laboratory of Natural History, California Academy of Science, British Museum, and Deutsche Entomologische Institut.

Undoubtedly an importation into this country. The writer has attempted to identify this species with one of the more than a hundred previously described, but without success. In addition to the material from Melrose Park, other specimens belonging to this species have been collected at Washington, D. C., and at Willow Grove, Pa. These lots are also from rose houses. The insect is reported as injurious in both larval and adult stages. The individuals of this species are very fragile, hardly a specimen of the more than a hundred examined but has lost one or more of its appendages.

EXPLANATION OF FIGURES

Fig. 1.—*Ptilodactyla serricollis* (Say). Male genitalia.

Fig. 2.—*Ptilodactyla exotica*, new species. Male genitalia.

Fig. 3.—*Ptilodactyla equilobata*, new species. Male genitalia.

Fig. 4.—*Ptilodactyla angustata* Horn. Male genitalia.

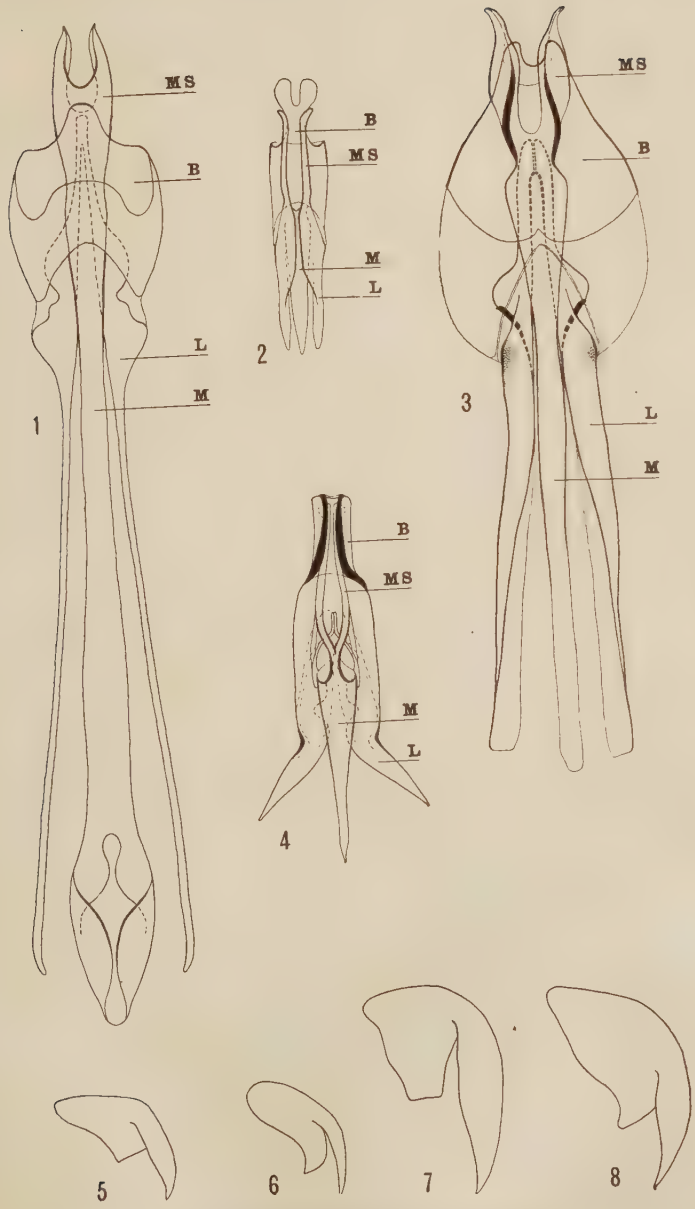
Fig. 5.—*Ptilodactyla exotica*, new species. Tarsal claw of anterior leg of male.

Fig. 6.—*Ptilodactyla angustata* Horn. Tarsal claw of anterior leg of male

Fig. 7.—*Ptilodactyla serricollis* (Say). Tarsal claw of anterior leg of male.

Fig. 8.—*Ptilodactyla equilobata*, new species. Tarsal claw of anterior leg of male.

Lettering uniform on Figures 1–4: B = basal piece; MS = median strut; M = median lobe; L = lateral lobe.



CHAPIN—NORTH AMERICAN PTILODACTYLA

KEY TO THE NORTH AMERICAN SPECIES OF ENALLAGMA, WITH A DESCRIPTION OF A NEW SPECIES

(ODONATA: ZYGOPTERA)

BY C. FRANCIS BYERS

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The genus *Enallagma* numbers thirty-eight species* in North America. It is the second largest of our Odonata genera, being surpassed only by the genus *Gomphus*. The problem of making a key for the separation of these species is indeed a difficult one. The results in the case of the female key are far from satisfactory. The separation of the female Enallagma is notoriously difficult, and until a large collection of representative forms "in coitu" is made and these thoroughly studied, the condition is not apt to be greatly alleviated. The males can be distinguished by a comparison of the superior abdominal appendages. Of the immature forms only fourteen of the thirty-eight species are known; of these Garman (1917) has keyed eleven, the species not included being *anna*, *praevarum* and *ebrium*. These will not be considered further in this paper.

In working over the material at Cornell University available for these keys, I turned up the following new species.

Enallagma culicinorum[1] new species.

Description.—Male. Superior abdominal appendages in profile view about as long as the dorsum of the tenth segment, bifid, the lower basal branch shorter, extending posteriorly over one-half the length of the appendage, directed ventrally and slightly inward, subrectangular in shape, the lower angles rounded, width equal to half the widths of the entire appendage. The upper branch long, apical and inferior margins straight, end enlarged with the superior margin convex. The superior

*As this paper goes to press, the author has discovered a new species of *Enallagma* from Georgia and Florida to be described, the nearest relative of which is *exsulans*. At Dr. Walker's suggestion I have also relegated *Enallagma luniferum* Muttkowski to the synonomy of *Coenagrion angulatum* Walker, thus retaining the number of North American species in the genus as 38.

[1] Named after the dipterous family Culicidae the species of which form a favorite food of these insects.

appendage, looking from above and within, has the upper branch giving off a ventrally directed tooth just caudad to the point where the cephalic margin of the lower branch joins the upper. On the inner surface of the lower branch there is a tubercle that is not visible in a straight profile view. Inferior appendages about three-fifths as long as the superior, their tips directed upward.

Nasus entirely black, except for a pale area along the lateral and anterior margins. Anterior margin of the frons pale. Remainder of frons and vertex entirely black. Antennae black. Postocular spots large, triangular, not connected, and separated from the pale color of the rear of the head by a bar of black.

Prothorax black, pale as follows: a transverse stripe covering the major portion of the first lobe, and narrowly connected with two longitudinal spots on either side of the dorsum of the middle lobe, sides of the middle lobe, and a narrow transverse stripe on the posterior border of the hind lobe. The hind lobe is entire and convex.

Thorax pale, black as follows, a broad mid-dorsal stripe, a narrow humeral stripe, connected with the dorsal one along the base of the mesostigmal plate, a small spot at the caudal end of the metapleural suture.

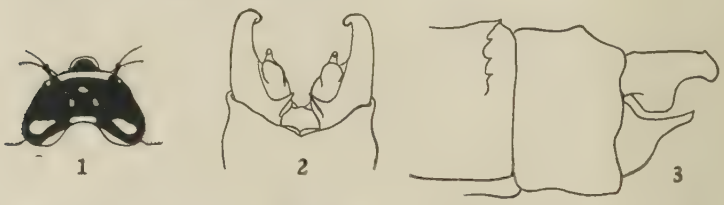

Fig. 1. Dorsal view of head of *Enallagma culicinorum*. Fig. 2. Dorsal view of superior appendage. Fig. 3. Profile of superior appendage.

Legs pale, a dark line on the outer surface of the tibiae and femora. Wings with M_2 arising nearest the fifth postnodal cross vein in the fore wings and mid-way between the fourth and fifth in the hind wing. Three antenodal cells. Ten postnodal cross-veins.

Abdomen pale with the following black; a small basal spot on one. An irregular apical spot and a narrow apical ring on two. Irregular apical spots and small apical rings occupying one-fourth the terga of three and four, and two-thirds of five and six, all of seven except a basal pale ring, and all of ten. Eight and nine entirely pale except for a very fine transverse line on the apical border of eight.

In the specimens at hand the "pale" color is a lemon yellow or blue, and the dark color varies from a shining black to a brownish-black. The coloration may vary in older specimens.

Holotype.—Male, in alcohol. Collected by Dr. James G. Needham, in the Logan River, at the sugar works near Logan City, Utah. The type and one paratype are in the Cornell University collection. No. 803.

Affinities.—*Enallagma culicinorum* belongs in a group with *anna, praevarum* and *eiseni*. It is perhaps more closely related to *anna* than to the other species. In coloration and in the dorso-interior view of the superior appendages it suggests *anna*. It differs from *anna* in the coloration of the basal segment of the antennae (pale in *anna*, black in *culicinorum*), the post-ocular spots (connected in *anna*, separated in *culicinorum*) and in the extent of black on the abdomen (more reduced in *culicinorum*). However, from a profile view the superior abdominal appendages are quite distinct from those of other species, probably favoring *eiseni* and *traviatum* more closely than the others. In *eiseni* the basal projection of the superior appendages is triangular and in *E. culicinorum* it is subrectangular.

The female of *Enallagma culicinorum* is not known.

Key to the Males

The North American males seem to fall into four natural groups based on the form of the superior abdominal appendages. Unfortunately the females do not follow the same grouping, thus indicating that the groups are artificial and not phylogenetic. Be that as it may, they are convenient and may be defined as follows:

Group A.—Superior abdominal appendages not bifid, the superior margin at most only slightly indented (*durum, minusculum*), small, their greatest length less than that of the tenth abdominal segment. Dorsum of abdominal segment two blue with a black spot or spots of various size, but never reaching from the base to the apex of the segment (except *divagans*). Color blue black.

Boreale[2], *minusculum, durum, cyathigerum, divagans, clausum, geminatum, piscinarium, hageni, recurvatum* and *laterale*.

[2] There have been described from North America four species of *Enallagma* that are very closely related or synonymous. These are *annexum* Hagen, 1861, *robustum* Selys, 1875, *boreale* Selys, 1875, and *calverti* Morse, 1895. Also belonging to this complex is *cyathigerum* described from Europe by Charpentier in 1840. The characters separating these species are very minute and variable, and though the types are not available, after studying a series of specimens, I consider the relationship and synonomy to be as follows:

Group B.—Superior abdominal appendages bifid, the inferior arm as long or longer than the superior. With or without a tubercle between the arms.

Ebrium, exsulans, pallidum and *antennatum* (without tubercle).

Civile, carunculatum and *doubledayi* (with tubercle).

Group C.—Superior abdominal appendages bifid, inferior arm shorter than the superior, usually ventrally directed, appearing in some species as a triangular or subrectangular basal attachment to the superior.

Coecum, pravevarum, anna, culicinorum, aspersum, basidens, traviatum, semicirculare, cardenium, and *eiseni.*

Group D.—Superior abdominal appendages not bifid, large, as long or longer than the dorsum of ten (except *sulcatum*). Dorsum of abdominal segment two with black extending from the base to the apex. Color orange, yellow, and pale blue, and black:—

Pollutum, vesperum, laurenti, cultellatum,[3] *dubium, concisum, signatum, pictum,* and *sulcatum.*

The species within these groups are listed in, what I believe to be, their phylogenetic order. The keys for the separation of these species follow.

Group A.

1. Abdominal segments eight and nine unmarked with black..2
   Abdominal segment eight marked with black.....10
2. Abdominal segment two with dorsum entirely black. *divagans.*
   Abdominal segment two blue with a black spot.....3

Enallagma cyathigerum Charpentier, 1840 = *Enallagma annexum* Hagen, 1861, (See Calvert, Biologia Centralia Americana, p. 109); and *Enallagma robustum* Selys, 1875.

Enallagma boreale Selys, 1875 = *Enallagma calverti* Morse, 1895.

In the original description of *boreale*, Selys states, "The black superior "comma" (virgule) of the second lateral suture prolonged into a line on the suture to the base of the posterior legs." In typical "calverti" this line only reaches at the most about one-half the above mentioned distance. However, an occasional specimen is found, identical in all other respects with the *calverti* of Morse, in which the black line of the second lateral suture is as Selys described it for *boreale*. As the length of this spot or line is a variable character it seems best to relegate the better known "calverti" to the synonomy of the untypical *boreale.*

[3] Dr. Kennedy, makes *Enallagma cultellatum* the type species of anew genus, *Neoerythromma*, the separation of genera being based on the morphology of the penis.

3. Inferior appendages longer than the superior.....4
   Inferior appendages as long as the superior or shorter....7
4. M_2 arising between the third and fourth postnodal cross vein in the hind wings.....*hageni.*
   M_2 arising between the fourth and fifth postnodal cross vein in the hind wings.....5
5. Superior appendages with end blunt.....*boreale.*[4]
   Superior appendages with end acute.....6
6. Acute tip of superior appendages turned ventrally. *clausum.*
   Acute tip of superior appendages turned dorsally. *cyathigerum.*
7. Abdominal segments three to five at least one-third blue.9
   Abdominal segments three to five mostly black.....8
8. Superior appendages with an introduced tubercle. (*Coenagrion angulatum*) *luniferum.*
   Superior appendages without a tubercle.....*piscinarium.*
9. Antenodal cells four or five.....*durum.*
   Antenodal cells three.....*minusculum.*
10. Abdominal segment nine marked with black...*geminatum.*
    Abdominal segment nine entirely blue.....11
11. Superior appendages with tip recurved.....*recurvatum.*
    Superior appendages with superior margin slightly convex. *laterale.*

Group B

1. Without a tubercle between the arms of the bifid superior abdominal appendages.....2
   With a tubercle between the arms of the superior abdominal appendages.....5
2. Dorsum of abdominal segment two blue with a black spot. *ebrium.*
   Dorsum of abdominal segment two wholly black.....3
3. Superior appendages with the two arms approximate, the inferior arm longer than the superior.....*exsulans.*
   Superior appendages with arms widely divergent, the inferior arm equal in length to the superior.....4
4. Abdominal segments eight to ten almost entirely pale blue *pallidum.*
   Abdominal segments eight and ten black on the dorsum. *antennatum.*
5. Dorsum of abdominal segments four to five more than half black.....*carunculatum.*
   Dorsum of abdominal segments four to five less than half black.....6

[4] In this key I have considered *calverti* a synonym of *boreale* and *robustum* as a synonym of *cyathigerum.*

6. Superior appendages with tubercle projecting noticeably beyond the dorso-caudal angles, when viewed from the side. . . . . *doubledayi.*
   Superior abdominal appendages with the tubercle not so projecting, arms longer and more divergent. . . . *civile.*

Group C

1. With a tubercle between the arms, visible in a profile view. 2
   Without a tubercle between the arms, or if one, not visible in a profile view. 4
2. Black markings on abdominal segment two U-shaped. Pale color on three violet. Superior appendages widely bifid in profile view, superior branch the longer. . . *coecum.*
   Black markings on abdominal segment two not U-shaped. Pale color on three blue. 3
3. Superior appendages with apex of superior arm directed straight back, inferior arm with apex directed posteriorly. *praevarum.*
   Superior appendages with apex of superior arm directed ventrally, inferior arm with apex directed ventrally. *anna.*
4. Segment two with the black of the dorsum usually extending from base to apex. 5
   Segment two with black of dorsum in isolated spots, streaks or bands. 7
5. M_2 arising nearest fifth postnodal cross vein in the fore wing, fourth in the hind wing. Eight to ten postnodal cross veins. 6
   M_2 arising nearest the fourth postnodal cross vein in the fore wing, third in the hind wing. Five to six postnodal cross veins. . . . . *basidens.*
6. Superior appendages with inferior arm appearing as a broad triangular process, the apex directed ventrally. . . *eiseni.*
   Superior appendages with the inferior arm appearing as a rounded basal projection. . . . . *traviatum.*
7. Caudal half at least of segment seven pale. 8
   Segment seven with dorsum almost entirely black. 9
8. Segment eight entirely pale. . . . . *aspersum.*
   Segment eight with lateral dark areas. . . *coecum, cardenium.*
9. Segment ten blue with a narrow median stripe of black. *eiseni.*
   Segment ten entirely blue. . . . . *semicirculare.*
   Segment ten with the dorsum entirely black. . . *culicinorum.*

Group D.

1. Abdominal segment two with the dorsum entirely black . . . 2
   Abdominal segment two with black of dorsum assuming a U-shape, the arms of the U reaching from near the base to the apex so as to isolate a pale spot from the pale of the sides . . . . . *cultellatum.*
2. Dorsum of abdominal segment nine pale blue or orange 3
   Dorsum of abdominal segment nine black, pale postocular spots linear, not confluent with the pale color of the rear of the head. Pale antehumeral stripe narrower than the black humeral stripe 7
3. Pale postocular spots directly confluent with the pale color of the rear of the head. Middle prothorasic lobe predominantly pale on dorsum . . . . . *laurenti.*
   Pale postocular spots not directly confluent with the pale color of the rear of the head, although they may be indirectly confluent therewith *via* the pale transverse stripe that connects the postocular spots with each other. Middle prothoracic lobe predominantly black on the dorsum 4
4. Pale antehumeral stripe narrower than the black humeral stripe 5
   Pale antehumeral stripe as wide as, or wider than, the black humeral stripe 6
5. Ninth abdominal segment orange . . . . . *pollutum.*
   Ninth abdominal segment blue . . . . . *sulcatum.*
6. Ninth abdominal segment yellow . . . . . *signatum.*
   Ninth abdominal segment blue . . . . . *vesperum.*
7. The two basal joints of the antennae black, no pale spots about the ocelli . . . . . *dubium.*
   The two basal joints of the antennae pale. Two light spots between the median and lateral ocelli 8
8. Second lateral thoracic black stripe abruptly narrowed at three-fourths or two-thirds its length to a narrow line. *pictum.*
   Second lateral thoracic black stripe of uniform width from anterior to posterior end . . . . . *concisum.*

Key to the Known Females

As previously mentioned the female Enallagmas do not fall into the same four groups as the males do, with the possible exception of Group D. The known females of this group can be separated from the other female Enallagmas by the presence of two dorsal pits on the middle thoracic lobe, if exception be made of *hageni* and *recurvatum*, which are two Group A forms possessing these pits. The females therefore will be dealt with

in one key. Of the thirty-eight species of *Enallagma* described from males only twenty-eight of the corresponding females are known. The ten unknown or undescribed females are: *clausum, dubium, eiseni, semicirculare, laurenti, luniferum, culicinorum, piscinarium, laterale* and *minusculum.*

1. Middle prothoracic lobe with a pair of dorsal pits.....20
   Middle prothoracic lobe without a pair of dorsal pits....2
2. Tenth abdominal terga usually without black markings..3
   Tenth abdominal terga with black markings.....9
3. Dorsum of abdominal segment nine mostly black.....4
   Dorsum of nine entirely blue or with black lines or spots...5
4. Four to five antenodal cells.....*durum.*
   Two to three antenodal cells.....*antennatum.*
5. Dorsum of nine entirely blue.....*traviatum*
   Dorsum of nine with black lines or spots.....6
6. Dorsum of nine with a pair of black spots on the basal half. 7
   Dorsum of nine without black spots, these being replaced by two dorso-lateral lines either joined or separated at the meson.....8
7. Postnodal cross veins ten to eleven. Distribution, Eastern United States west to Texas.....*exsulans.*
   Postnodal cross veins five to six. Distribution, Western United States east to Texas.....*basidens.*
8. Abdominal segment eight black with pale blue lateral spots. *divagans.*
   Abdominal segment eight blue with a dorsal stripe of black, fully four-fifths as wide as the segment in dorsal view. *pallidum.*
9. Dorsum of abdominal segment eight black with a large blue spot on either side of the meson in the cephalic half. 10
   Dorsum of abdominal segment eight not so marked....11
10. Abdominal segment seven black.....*geminatum.*
    Abdominal segment seven blue, never with more than a fine line of black.....*aspersum.*
11. Abdominal segment eight entirely blue.....12
    Abdominal segment eight with some black.....13
12. Dorsum of abdominal segment two entirely black. *cardenium.*
    Dorsum of abdominal segment two blue with a black spot. *boreale, cyathigerum.*
13. Dorsum of abdominal segment one with black reaching from base to apex.....*civile.*
    Dorsum of abdominal segment one with black not reaching the apex.....14

14. Specimens collected west of the Mississippi.....15
Specimens collected east of the Mississippi.....17
15. Hind margin of the prothorax convex throughout.....16
Hind margin of the prothorax convex medially, slightly concave or truncate on either side.....*anna, praevarum.*
16. Abdominal segment eight entirely blue or with a black band on dorsum narrower anteriorly than posteriorly, nine black on dorsum.....17
Abdominal segment blue with apical fourth and sides black, nine black with apical blue spots.....*coecum.*
17. Mesostigmal plates with a diagonal ridge from the caudomesal to the cephalo-lateral angles.....*carunculatum.*
Mesostigmal plates without such a diagonal ridge.....18
18. M_2 arising beyond the fourth postnodal cross vein in the hind wings.....19
M_2 arising between the third and fourth postnodal cross vein in the hind wings.....*ebrium.*
19. Black color of the dorsum of abdominal segments four to seven always reaching the cephalic margins..*doubledayi.*
Black color of these segments never reaching the cephalic margins.....*boreale, cyathigerum.*
20. Black of abdominal segment two extending from base to apex.....21
Black of abdominal segment two in form of an apical ring and spot, remainder blue.
(common) *hageni,* (rare) *recurvatum.*
21. Prothoracic pits very shallow and situated near the hind lobe which is trilobate.....*cultellatum.*
Prothoracic pits deeper, hind lobe entire (pollutum-group, Williamson, 1922).....22
22. Black humeral stripe not touching the lower end of the mesostigmal plate (lamina), pale antehumeral stripe wider than the black humeral, metapleural suture with a black stripe on its uppermost fourth or fifth only.
vesperum.
Black humeral stripe touching the lower end of the mesostigmal plate.....23
23. Dorsum of segment ten pale.....24
Dorsum of segment ten black; prothoracic pits small, each with a pale area anterior and adjacent to it.....26
24. Prothoracic pits large, situated near the anterior border of the middle lobe, a pale area posterior and external to each. Mesostigmal plate black, a pale stripe from and including the dorsal tubercle downward and forward across the plate, the lower end of the plate deeply indenting the mesinfraepisternum.....*signatum.*
Prothoracic pits smaller situated at or near the mid-length of the middle lobe, pale color adjacent to each more extensive anterior to it or to its level, rather than posterior to it.....25

25. Mesostigmal plate barely touching the mesinfraepisternum. Anterior end of antehumeral stripe bordered with a broad stripe of black on the mesostigmal plate, which black widely separates the antehumeral stripe from the pale vertical stripe on the plate..... *sulcatum.*

Mesostigmal plate slightly but distinctly indenting the mesinfraepisternum. Antero-mesal end of the antehumeral stripe very narrowly separated by black from the extensive pale area of the mesostigmal plate. *pollutum.*

26. Prothoracic pits situated anterior to the middle of the middle lobe. Dorsal tubercle of the mesostigmal plate pale, from which a narrow pale stripe runs downward and forward across the plate; posterior to this pale stripe the plate is broadly black, grooved, and with its end very slightly indenting the mesinfraepisternum; the extensive black on the plate widely separates the lower end of the pale antehumeral stripe from the pale stripe on the plate..... *pictum.*

Prothoracic pits situated at about mid-length of the middle lobe. Dorsal tubercle of the mesostigmal plate pale colored, from which a pale line extends downward to or nearly to the lower end of the plate, the lower half of this pale line expanded to cover the plate to its anterior border; apparently the mesostigmal plate, the ventral mesostigmal plate and the mesepisternum converge to a point on the edge of the mesinfraepisternum; dorsal and humeral black stripes narrowly joined by a black stripe on the mesepisternum-mesostigmal plate suture.. *concisum.*

In working these keys it should be born in mind that keys to *Enallagma* are never entirely satisfactory because of the great variability of the characters, especially the important one of color; this leads to confusion and misidentification. No identification should be considered final until checked with a written description, and, in the case of the male, with a figure of the superior abdominal appendages. As it is not within the scope of this paper to supply either, I am appending an annotated bibliography giving the best sources for this information. A full set of figures will be published by Dr. James G. Needham in his forthcoming, "Handbook of the Odonata of North America."

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STUDIES IN THE NEOTROPICAL HESPERIOIDEA.

PAPER II.

BY ROSWELL C. WILLIAMS, JR.

This paper will deal with the insects of the genus *Epargyreus*, *Telegonus* (including *Thymele* auct.), *Aguna* (a new genus erected to take some species previously placed in *Eudamus* and *Epargyreus*) *Polygonus* and *Proteides*, giving outline drawings of the male genitalia and records of the distribution of the species as represented in the collection of the Academy of Natural Sciences of Philadelphia into which has been incorporated my own collection.

The plates illustrate the new species and forms and those which have not been previously or adequately figured. These are from paintings made by Miss Helen Winchester. On plate XXV figs. 2 and 3, I have figured the types of *Eudamus dorysses* form *tenuis* and form *interruptus* described in my previous paper of this series.[1]

The synonymy includes reference to previous figures of the male genitalia and good figures of the insects, but is not intended to include all previous references to the species.

Epargyreus tityrus (Fabricius)

1775. *Papilio tityrus* Fabricius, Syst. Ent., p. 532.
1776. *Papilio clarus* Cramer, Pap. Exot., I, p. 66, pl. 41, figs. E, F. (Surinam).
1889. *Epargyreus tityrus* Scudder, But. New England, II, p. 1399, pl. 9, fig. 8; pl. 35, fig. 36. (♀ genitalia).
1922. *Epargyreus tityrus* Skinner and Williams, Trans. Amer. Ent. Soc., XLVIII, p. 114, fig. 8. (♂ genitalia).

Tityrus has a wide distribution in the United States and is figured by Smith and Abbot, Boisduval and Leconte, Scudder, Harris, Maynard, Holland, Comstock, French, Elrod, Beutenmuller, Wright and Draudt. Godman and Salvin did not receive it from Mexico and Central America, and seem to doubt its presence there, stating it replaces *exadeus* above the Mexican line. *Clarus*, from Dutch Guiana, seems to be, a small *tityrus*,

[1] Trans. Am. Ent. Soc. LII, p. 65, 1926.

and we have a specimen from Staudinger labeled "*clavicornis* H. S., Bahia, Brazil," which is practically identical with a Philadelphia example of *tityrus*.

The male genitalia are very similar to those of *exadeus*, and the two species can hardly be separated on these characters. The toothed ornamentation at the extremity of the valves varies somewhat in both species.

Epargyreus tityrus aberration **obliteratus** Scudder

1889. *Epargyreus tityrus obliteratus* Scudder, But. New England, II, p. 1402, 1889.

This aberration has reduced spots on the primary wings and a considerably enlarged silver spot on the secondary wings below.

Epargyreus tityrus aberration **smythi** new name

1908. *Eudamus tityrus* Smyth, [not Fabricius], Ent. News., XIX, p. 192, pl. 10. (Aberration; Charleston, South Carolina.)

Mr. Ellison J. Smyth, Jr., figures a remarkable aberration in which the spots of the primaries are greatly enlarged and extended, the discal spots becoming a large triangular discal patch, separated by the veins; and the apical dots becoming a series of dashes extending along the costa and around the upper part of the discal patch. On the under side the silver spot "is reduced to a mere dash along the base of the cell, and an isolated, faint mark at right angles to, and touching sub-costal vein opposite base of cell."

As attention is now being called to these occasional forms by assigning them names, I christen this for Professor Smyth, who formerly studied the Lepidoptera, and has published valuable papers.

Epargyreus exadeus (Cramer) (Figs. 1 and 2)

1782. *Papilio exadeus* Cramer, Pap. Exot., III, p. 118, pl. 260, fig. C. (Surinam).

1869. *Eudamus clavicornis* Herrich-Schaffer, Corres. Blat. Regensburg, XXIII, p. 186.

1872. *Epargyreus orizaba* Scudder, Rep. Peabody Acad. Sci., IV, p. 70. (Guatemala).

1888. *Thymele exadeus* Staudinger, Exot. Schm., p. 290, pl. 98 (♂).

1911. *Eudamus (Epargyreus) exadeus* Skinner, Trans. Amer. Ent. Soc., XXXVII, p. 194, pl. 10. (♂ from San Luis Obispo, California figured).

1922. *Epargyreus exadeus* Draudt, Seitz's Macrolep., V, p. 860, pl. 166, e.

1922. *Epargyreus exadeus*, Skinner and Williams, Trans. Amer. Ent. Soc., XLVIII, p. 114, fig. 9. (♂ genitalia).

A widely distributed species from Southern California south through Mexico, Central and South America. The type from Dutch Guiana, Cramer compares with his figure of *idas*, as to size and location of the spots above, but states they are hyaline (instead of yellow-orange). There is considerable silver white below.

Our series from the northern coast of South America, Panama, and Central America average like this with reduced white markings below. The Californian insect figured by Dr. Skinner is similar, but below the white markings are reduced to three spots; an anal crescent, a larger extra-discal spot, and a small one at the end of the cell above. *Clavicornis* and *orizaba* with somewhat reduced markings only, I believe have been correctly placed as synonymous by Godman. Our specimens from Bolivia have still further reduced markings above and below, and Draudt figures as *exadeus* an individual with some of the spots above obsolete, and the silver spots below reduced to two small ones. Our series from Paraguay and the East and South of Brazil, on the average have larger spots above, and they are yellow-orange instead of hyaline, some of them agreeing above or both with the figure of *socus* Hubner, and although he does not indicate the type locality, I believe this name should be used for the South Eastern race, in which these larger markings seem to be the prevailing form.

There is some little variation in the male genitalia in the ornamentation at the extremity of the valvae. These differences do not seem to be correlated with any other characters, by means of which the insects with the different forms of valvae can be separated. The figures show the extremes in shape.

Record:—Mexico: Colima; Cordoba; Jalapa; Escuintla, Chiopas, (White). British Honduras: Corazal. Honduras: San Pedro Sula, (Lienhart). Costa Rica: Guapiles, (Harrower); Cartago, (Gillot). Panama: Santiago de Veraguas, (Davies); David and Gatun, (Harrower). Colombia: Cauca; Muzo; West Cordilleras; Minoa and Sierra San Lorenzo, Magdelena, (Rehn); 260 miles N. E. from Bogota. Ecuador: Huigra, (Rhoads); Riobamba. Bolivia: Coroico; Rio Songo.

Epargyreus exadeus race **socus** Hubner

[1816?] *Epargyreus socus* Hubner, Saml. Exot. Schm., pl. [?] figs. 1–4.

The prevailing form in the following localities. With larger yellow-orange spots above.

Records:—PARAGUAY: Villa Rica, (Jorgensen). ARGENTINE: Entre Rios. BRAZIL: Chapada and Corumba, Matto Grosso, (Smith); Santarem; Rio Janairo; Rio Grande de Sul; Sao Paula, (Pohl).

Epargyreus exadeus form **pseudexadeus** Westwood

1852. *Epargyreus pseudexadeus* Westwood, Doub. West. and Hew. Gen. Diur. Lep., II, pl. 80, fig. 1, *Goniloba exadeus* var. *pseudexadeus* p. 512.

This I believe to be as stated by Westwood a variety of *exadeus* with the spots of the fore wings larger. I have not seen one with such large yellow spots, but some of the individuals of the race *socus* nearly approach it. The under side is not shown so it is to be assumed that it is like *exadeus*. The figure in Seitz is not *pseudexadeus*, but the under side of *barisses*. Hew.

Epargyreus maysi (Lucas)

1856. *Eudamus maysi* Lucas, Sagra's Hist. Cuba, VII, p. 627. (Cuba.)
1862. *Goniloba egeus* Herrich-Schaffer, Corres. Blat. Regensburg, XVI, p. 142. (Cuba.)
1904. *Epargyreus egens* Mabille, Gen. Ins., Hesp. p. 23.
1916. *Epargyreus maysi* Holland, Ann. Carnegie Mus., X, p. 501, pl. 31, figs. 11, 12. (Nueva Gerona, Isle of Pines, Cuba.) [Probably Insular var. of *exadeus*.]
1922. *Epargyreus maysi* Draudt, Seitz's Macrolep., V, p. 861, pl. 166, e, f

Our specimens show two apical dots and two costal spots only, in the same location as the corresponding spots of *exadeus*, the other hyaline spots being absent. It is probably a form of *exadeus*, but as it is geographically removed and distinct, I follow Holland in assigning it specific rank.

Record:—CUBA: Guantanamo, (Ramsden).

The male genitalia do not differ from those of some typical *exadeus*.

Epargyreus barisses (Hewitson) (Fig. 3)

1874. *Eudamus barisses* Hewitson, Bolivian But., p. 22. (Bolivia).
1875. *Eudamus barisses* Hewitson, Exot. But., V, text and pl. Eudamus III, fig. 23.
1922. *Epargyreus pseudexadeus* Draudt (not Westwood), Seitz's Macrolep., VII, p. 861, pl. 166, e.

We have specimens from Cavias and Mapiri, Bolivia. The male genitalia are very similar to those of *tityrus* and *exadeus*.

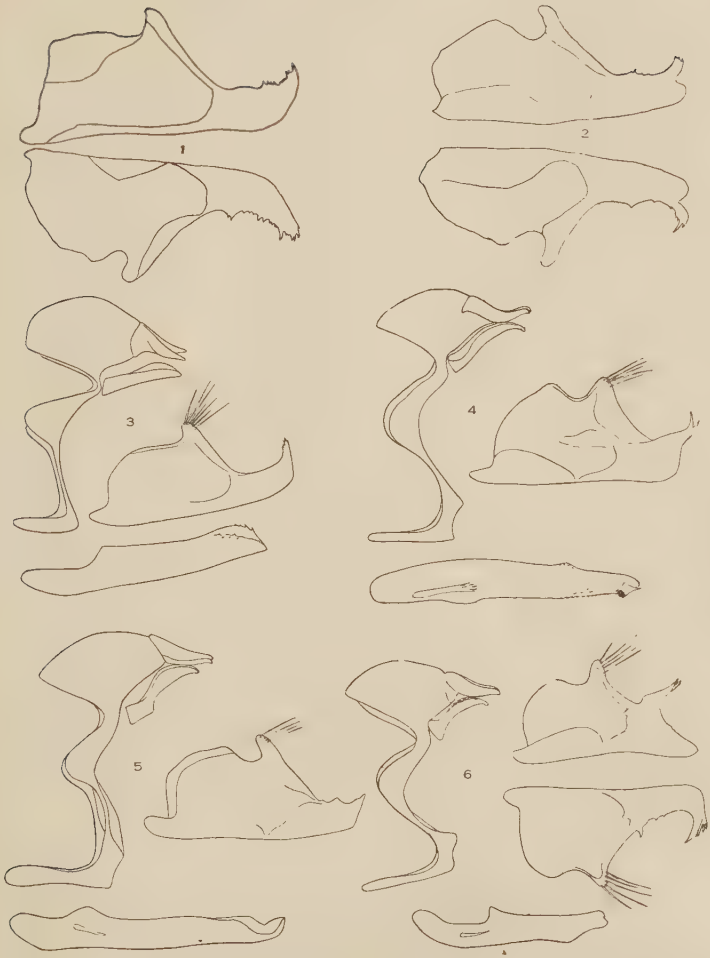

Fig. 1. *Epargyreus exadeus* Cramer, Muzo, Colombia. 2. Cartago, Costa Rica, (showing variation in valvae). 3. *Epargyreus barisses* Hewitson, Villa Rica, Paraguay. 4. *Epargyreus antaeus* Hewitson, Jamaica. 5. *Epargyreus tmolis* Burmeister, Buenos Aires, Argentine. 6. *Epargyreus enispe* Hewitson, Chapada, Matto Grosso, Brazil.

Epargyreus barisses form **argentea** Mabille and Boullet

1912. *Epargyreus barisses* var. *argentea* Mabille and Boullet, Ann. Sci. Nat., (9), XVI, p. 66. (Argentine).

I take this to be a form in which the silver bands are reduced to lines. We have specimens from Villa Rica, Paraguay, (Jorgensen) to which this name will apply. The male genitalia are very similar to those of *exadeus*.

Epargyreus antaeus (Hewitson) (Fig. 4)

1867. *Eudamus antaeus* Hewitson, Desc. Hesp., p. 8. [locality?]
1875. *Eudamus antaeus* Hewitson, Exot. But., V, text and pl. Eudamus III, fig. 18.

We have specimens from Jamaica which agree with Hewitson's figure. Mabille and Boullet record a ♀ from Haiti.

The male genitalia resemble those of *tityrus*, which it is like in the distinctly outlined silver spot below, though somewhat different in shape. The discal spots above are yellow-orange and large.

Epargyreus tmolis (Burmeister) (Pl. XXIV, fig. 1, ♂; fig. 2, ♀ and Fig. 5)

1875. *Eridamus tmolis* Burmeister, Rev. & Mag. Zool., (3), III, p. 53, pl I, fig. 1, (larvae); fig. 9, (head). (Buenos Ayres.)
1880. *Telegonus tmolus* Burmeister, Atlas Des. Phys. Rep. Argentine, Sec. 5, P. 2, p. 24, pl. IX. (larva etc.)
1886. *Eudamus tellus* Plotz (Weym. ms.), Stett. Ent. Zeit., XLVII, p. 84. (Buenos Ayres.)
1914. *Epargyreus barisses* var. *tuolus* Mabille, Gen. Ins., Hesp. p. 24.
1922. *Epargyreus barisses* form *tmolus* Draudt, Seitz's Macrolep., V, p. 86, pl. 166, g, [♀].

Mabille and Boullet cite *tellus* as a synonym of *tmolus* which is confirmed by the description.

We have a pair from Quilmes near Buenos Ayres, Argentine. The discal spots are golden and shining (in *barisses* dull orange-yellow), there are long ochreous hairs at the base of the secondaries. Below in the male the band is narrow and consists of a series of silver spots, the outer band an obsolescent whitish line; in the female the band consists of a dull yellow spot followed by some smaller ones, and the outer band practically obsolete. The conformation of these bands is not the same as in *barisses*, and the differences indicate that *tmolis* is a distinct species. I use the name *tmolis* as it was first spelled by Burmeister. The male genitalia closely resemble those of the *exadeus*, *barisses* group, but the shape of the valve is not identical.

Epargyreus zestos (Geyer)

1832. *Proteides zestos* Geyer, Hubner's Exot. Schmet., Zutr., p. 10, figs. 615, 616. (Surinam).
1881. *Proteides oberon* Worthington, Papilio, I, p. 132. (Marco Island, Florida.)
1922. *Epargyreus zestos* Draudt, Seitz's Macrolep., V, p. 861, pl. 166, g.
1922. *Epargyreus zestos* Skinner and Williams, Trans. Amer. Ent. Soc., XLVII, p. 114, fig. 7. (♂ genitalia.)

Besides Southern Florida specimens we have *zestos* from Gouvernors Harbor, Eleuthera, and Nassau, New Providence, Bahamas. It is without the silver spots below. The male genitalia are, however, practically the same as those of *tityrus*.

Epargyreus enispe (Hewitson) (Fig. 6)

1867. *Eudamus enispe* Hewitson, Desc. Hesp., p. 11. (South America.)
1875. *Eudamus enispe* Hewitson, Exot. But., V, text and pl. Eudamus III, fig. 22.
1882. *Eudamus rochus* Plotz, Stett. Ent. Zeit., XLIII, p. 94. (Brazil.)
1912. *Epargyreus bochus* Mabille and Boullet, Ann. Sci. Nat., (9), XVI, p. 68. [*rochus* Plotz]. [*enispe* without apical spots.]
1917. *Epargyreus enispe* Draudt, Seitz's Macrolep., V, p. 861, pl. 166, g.

We have a long series from Chapada, Matto Grosso, Brazil, (Smith). Usually there are two apical dots, but some specimens have only one, and in some these dots are obsolescent or obsolete.

The tegmen is very like that of the other species of the genus. The valvae are remarkable however in that they are asymetrical, the left valve like those of *exadeus* and *antaeus*, and the other quite different, this condition being a constant character. The aedoeagus is not provided with fine teeth at the outer border, as in the others of the genus, the chitinous termination being smooth and sharply defined.

TELEGONUS Hübner

Lindsay has pointed out that the type of *Telegonus* is *Papilio talus* Cramer as fixed by Butler in 1870 and not *Papilio anaphus* Cramer as proposed by Scudder in 1875. In the more recent literature *talus* has been placed with *coelus* in the genus *Goniurus* Hübner, *anaphus* and other associated species all without a costal fold in the male, in the genus *Telegonus*, and a similar group in which the males are provided with a costal fold in the genus *Thymele* Fabricius with pseudotype *Hesperia mercatus* Fabricius (=*Papilio fulgerator* Walsh) proposed by Scudder in

1875. Lindsay again points out that the type of *Goniurus* is *Papilio simplicius* Stoll as fixed by Butler in 1870, and the type of *Thymele* is *Papilio tages* Linnaeus as fixed by Westwood in 1840, neither of which species is congeneric with *talus*. The shape and pattern of the wings of *talus* and *fulgerator* are very similar, the arrangement of the hyaline spots, and the green coloration indicate their affinity and the characters of the male genitalia are so similar that the whole group heretofore placed in *Thymele* can well be placed with *talus* and the group heretofore placed in *Telegonus* and differing principally by the absence of the costal fold but with very similar characters in the male genitalia, can be left in this genus.

Of the species mentioned below those from *talus* to *phalaecus* have a costal fold, the balance, *anaphus* to *creteus*, lack the costal fold in the male.

Telegonus talus (Cramer) (Fig. 7)

1779. *Papilio talus* Cramer, Pap. Exot., II, p. 22, pl. 176, fig. D. (Surinam.)
1823. *Hesperia ausonius* Latrielle, Ent. Meth., IX. p. 741.
1848. *Papilio lucidator* Sepp., Sur. Vlind., I, p. 77, pl. 35. (Surinam.)
1856. *Eudamus sumadue* Lucas, Sagra's Hist. Cuba, VII, p. 625. (Cuba.)
1893. *Goniurus talus* Godman and Salvin, Biol. Cent. Amer., Rhop. II, p. 288, pl. 76, fig. 2. (♂ genitalia.)
1922. *Goniurus talus* Draudt, Seitz's Macrolep., V. p. 860, pl. 166, d.

Records:—CUBA. JAMAICA. HAITI. SAN DOMINGO. COSTA RICA: Guapiles, (Harrower). PANAMA: Gatun, Canal Zone, (Harrower). COLOMBIA: Magdalena, (Rehn). BRITISH GUIANA: Bartica.

Telegonus fulgerator (Walsh) (Fig. 8)

1775. *Papilio fulgerator* Walsh, Naturf., (7), VII, p. 115, pl. 1, figs. 2 a, b. (Locality ?).
1782. *Papilio fulgerator* Cramer, Pap. Exot., III, p. 162, pl. 284, figs. A, B. (Surinam.)
1793. *Hesperia mercatus* Fabricius, Ent. Syst., III, p. 332.
1848. *Papilio fulminator* Sepp., Sur. Vlind., I, p. 77, pl. 34.
1866. *Goniloba azul* Reakirt, Pro. Acad. Nat. Sci. Phila., XVIII, p. 340. (Vera Cruz, Mexico.)
1881. *Eudamus misitra* Plotz, Ent. Zeit. Stet., XLII, p. 502. (Mexico).
1893. *Thymele fulgerator* Godman and Salvin, Biol. Cent.-Amer., Rhop. II, p. 311, pl. 78, fig. 1. (♂ genitalia.)
1922. *Thymele fulgerator* Draudt, Seitz's Macrolep., V, p. 865, pl. 167, f.
1922. *Thymele enotrus* Draudt, [not Cramer], Seitz's Macrolep., V, p. 866, pl. 167, f.

Fig. 7. *Telegonus talus* Cramer, Santo Domingo. 8. *Telegonus fulgerator* Walsh, Jalapa, Mexico. 9. *Telegonus brevicauda* Plotz, San Pedro Sula, Honduras. 10. *Telegonus tucuti* Williams, (type), Gatun, Canal Zone, Panama. 11. *Telegonus naxos* Hewitson Sao Paula, Brazil. 12. *Telegonus aulus* Plotz, Villa Rica, Paraguay.

Godman and Salvin have placed *mercatus*, *fulminator* and *misitra* in the synonymy, and Godman has added *azul*. The original figure, and that of Cramer show three apical dots, Sepp shows four, our long series show from three to five, in the females usually larger. *Enotrus* of Draudt is certainly not Cramer's species, which has no apical spots. The figure of the under side shows a normal *fulgerator*, and the figure of *fulgerator* upper, is a female, and under, is a large male. *Fulgerator* always has a white costal border to the lower wings at the base, cut above by a dark line.

The male genitalia are similar to those of *anaphus*. The valve varies in the length of the external projecting point which is sometimes shortened considerably, a rather obtuse one being figured by Godman and Salvin. This variation does not seem to be associated with the number of apical spots or any other variation in maculation or color.

Records:—MEXICO: Colima; San Juan Evangeliste; Vera Cruz. HONDURAS: San Pedro Sula, (Lienhart). COSTA RICA: Alajuela, (Calvert). GUATEMALA. PANAMA: Santiago de Veraguas, (Davies); Gatun, Canal Zone, (Harrower); Las Cascadas, (Shine). COLOMBIA: 260 miles N. E. of Bogota; Muzo; Sierra San Lorenzo, Magdalena, (Rehn). VENEZUELA: Cariaquito, (Brown); Porto Cabello, (Klages). BRITISH GUIANA: Potaro; Bartica. FRENCH GUIANA. DUTCH GUIANA: Paramaribo, (Mayo). ECUADOR: Riobamba; Huigra, (Rhoads). BOLIVIA: Coroico; Rio Songo. BRAZIL: Chapada, Matto Grosso, (Smith); Sao Paula, (Pohl); Upper Amazon. ARGENTINE: Espir Santo. PARAGUAY: Villa Rica, (Jorgensen).

Telegonus brevicauda (Plotz) (Fig. 9)

1886. *Goniurus brevicauda* Plotz, Ent. Zeit. Stet., XLVII, p. 83. (Chiriqui.)
1893. *Thymele eniopeus* Godman and Salvin, Biol. Cent. Amer., Rhop. II, p. 312, pl. 78, figs. 3, 4. (♂ Conchales, Nicaragua; Chiriqui).

We have two males from San Pedro Sula, Honduras, (Lienhart) which agree with the Godman and Salvin figure. Godman has placed *eniopeus* as synonymous with *brevicauda* of Plotz, and the description confirms this and refers to the short tail. The Draudt figure in Seitz's Macrolepodiptera cannot represent Plotz's species as it lacks the tail.

Telegonus tucuti new species (Pl. XXV, fig. 5, and Fig. 10)

Wings above dark brown with bright blue-green at base. On primaries a discal band of hyaline spots, two costal lines, a cellular spot constricted centrally, a larger rhomboid spot and a triangular spot toward the outer margin. Beyond this band a central line and three apical dots (one paratype has a fourth). Wings below lighter brown, primaries with hyaline spots as above, the inner margin lighter with an indication of a whitish patch in one paratype. Secondaries with whitish and yellowish scales and hairs at base, two slightly darker bands, the outer one faintly outlined with some more yellowish scales especially towards the inner angle. Palpi, head and collar dark green, thorax and upper abdomen bright blue-green; below, palpi, body and legs ochreous. Primaries rather pointed, secondaries with acute anal angle. Fringes only slightly lighter than the ground color. Expanse 52 mm. Center of thorax to tip of primary 30 mm., to anal angle of secondary 23 mm.

Described from four males. Type and one paratype; Gatun, Canal Zone, Panama, VII, 24, 1916, (Harrower). One paratype; Coroico, Bolivia, and one paratype; Guapiles, Costa Rica, VI, 4, 1909, (Calvert).

This species resembles *brevicauda* closely, but it lacks the tail, the anal angle being like that of *enotrus* in shape. The male genitalia differ from those of *brevicauda* in the shape of the valvae.

Named for a tribe of San Blas Indians.

Telegonus naxos (Hewitson) (Fig. 11)

1867. *Eudamus naxos* Hewitson, Desc. Hesp., p. 10. (Brazil).

1875. *Eudamus naxos* Hewitson, Exot. But., v, text and pl. Eudamus III, fig. 19.

We have several from Sao Paula, Brazil, (Pohl). The spots on the secondaries below are very characteristic. The insect figured by Draudt[2] is not *naxos*. The male genitalia are similar to those of *fulgerator*.

Telegonus aulus (Plotz) (Fig. 12)

1881. *Eudamus aulus* Plotz, Ent. Zeit. Stet., XLII, p. 503. (Brazil.)

1888. *Thymele fulviluna* Mabille, Le Natür., (2), x, p. 171, fig. 9. (Blumenau, Brazil.)

1893. *Thymele fulviluna* Godman and Salvin, Biol.. Cent. Amer., Rhop. II, p. 313, pl. 78, figs. 5, 6.

1922. *Thymele aulus* Draudt, Seitz's Macrolep., v. p. 867, pl., 167 a. [Under side possibly, not upper side.]

[2] Seitz's Macrolep. V, plate 168, a.

Godman who examined the original drawings of this species says the ♂ is *enotrus* Cramer, and the ♀ is *fulviluna* Mabille. Mabille and Boullet select the ♀ as type and sink *fulviluna*.

I have identified our species from Villa Rica, Paraguay, (Jorgensen) from the Godman and Salvin figure, which shows a fulvous ring towards the inner margin of the secondaries below, and this is present in both sexes. The first Draudt figure, showing the upper side of the wings, undoubtedly represents *enotrus* Cramer. The figure of the underside is that of a different species. The angulated apex of the wing is like that of *fulviluna*, but it carries on the primaries, below, a large white patch at the base of the discal band in our specimens only represented by a somewhat lighter shade than the ground color, and the secondaries show fulvous lines outlining a discal band, in our specimens represented by some fulvous lines and the conspicuous fulvous circle mentioned above. I adopt the name *aulus*, following Godman, the best authority, and Mabille who sank his own species, but with further study and material, it may be found that we are dealing with two species or distinct forms of one.

The male genitalia show a change from type in the termination of the valvae.

Telegonus egregius Butler (Fig. 13)

1870. *Telegonus egregius* Butler, Trans. Ent. Soc. London, IV, p. 494. (Locality?).

1871. *Telegonus egregius* Butler, Lep. Exot., p. 65, pl. 25, fig. 11.

1893. *Thymele egregius* Godman and Salvin, Biol. Cent. Amer., Rhop. II, p. 314, pl. 78, fig. 9. (♂ genitalia.)

1922. *Thymele egregius* Draudt, Seitz's Macrolep., V, p. 866, pl. 168, b.

Egregius differs from its cogeners in the rather broad yellowish white fringes of the secondaries. On the outer margin and below, this color carries into the wing, merging into the brown ground color. The spots are very variable, in our own series ranging from a completely immaculate individual to one with two apical dots and a band of two costal dots, an extra-cellular triangle, a cellular dash, a rectangle below the cell, and a triangle below this, removed towards the margin. There last spots seem to be the most persistent.

Records:—MEXICO: Colima; Jalapa. PANAMA: Chiriqui. COLOMBIA: West Cordilleras; Eastern part.

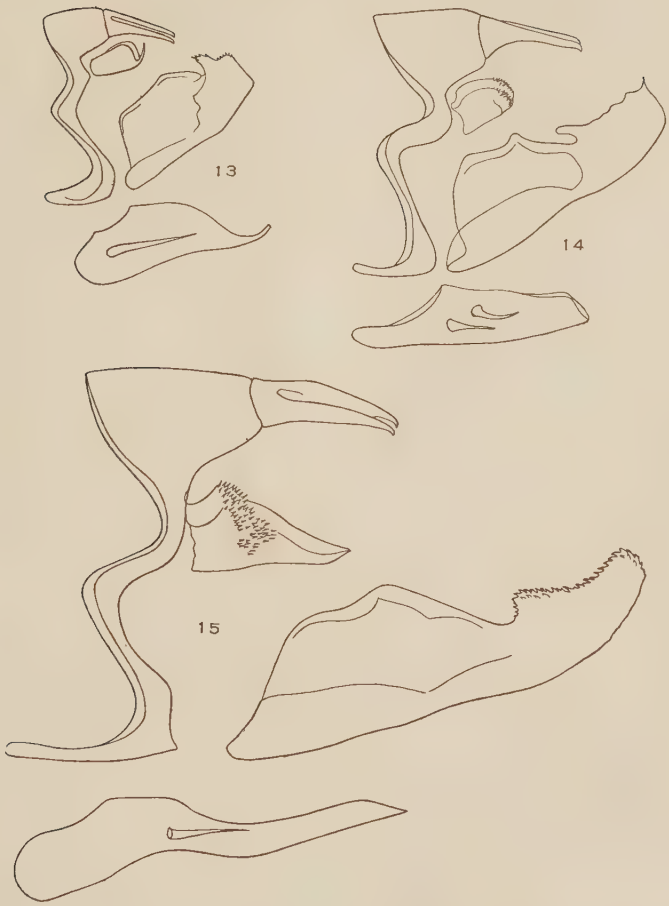

Fig. 13. *Telegonus egregius* Butler, Jalapa, Mexico. 14. *Telegonus enotrus* Cramer, Villa Rica, Paraguay. 15. *Telegonus aulestes* Cramer, Manicore, Rio Madeira, Brazil.

Telegonus alexanderi (Weeks)

1906. *Thymele pervivax* var. *alexanderi* Weeks, Psyche, XIII, p. 71. (Saupure, Venezuela.)
1911. *Thymele pervivax alexanderi* Weeks, Ill. Diur. Lep., II, p. 15, pl. 9.
1922. *Thymele pervivax aleanderi* Draudt, Seitz's Macrolep., V, p. 866.

We have a single male from Rio Songo, Bolivia, which agrees with the description and figure. I cannot agree that this should be considered a form of *pervivax* Hub. (for *pertinax* Stoll not Cramer) which has a prominent discal band of four white spots.

Telegonus christyi Sharpe (Pl. XXV, fig. 7)

1898. *Telegonus christyi* Sharpe, Proc. Zool. Soc. London, 1898, p. 366. (La Vega, San Domingo.)
1920. *Thymele augustus* Skinner, Ent. News, XXXI, p. 133. (San Domingo.)

The male of this species has a narrow costal fold.

Telegonus enotrus (Cramer) (Fig. 14)

1782. *Papilio enotrus* Cramer, Pap. Exot., IV, p. 144, pl. 364, figs. G, H. (Locality?).
1893. *Thymele enotrus* Godman and Salvin, Biol. Cent. Amer., Rhop. II, p. 312, pl. 78, fig. 2. (♂ genitalia.)
1922. *Thymele aulus* Draudt, [not Plotz], Seitz's Macrolep., V, p. 867, pl. 168, a. [First figure, upper side.]

We have a series from Villa Rica, Paraguay (*Jorgensen*) which agree with the Cramer figure and the genitalia as figured by Godman and Salvin.

Telegonus aulestes (Cramer) (Fig. 15)

1782. *Papilio aulestes* Cramer, Pap. Exot., III, p. 161, pl. 283, figs. E, F, G. (Surinam.)
1791. *Papilio narcosius* Stoll, Sup. Cramer's Pap. Exot., p. 171, pl. 39, fig. 8.
1893. *Thymele aulestes* Godman and Salvin, Biol. Cent. Amer., Rhop. II, p. 315, pl. 78, fig. 15. (♂ genitalia.)

Several species seem to have been confused under this name. I believe, however, that Godman and Salvin have correctly identified this species, in their figure of the male genitalia. We have a specimen from Manicore, Rio Madeiro, Brazil, which agrees with Cramer's figure more closely than any of the others, and the male genitalia of this individual agree with the Godman and Salvin figure.

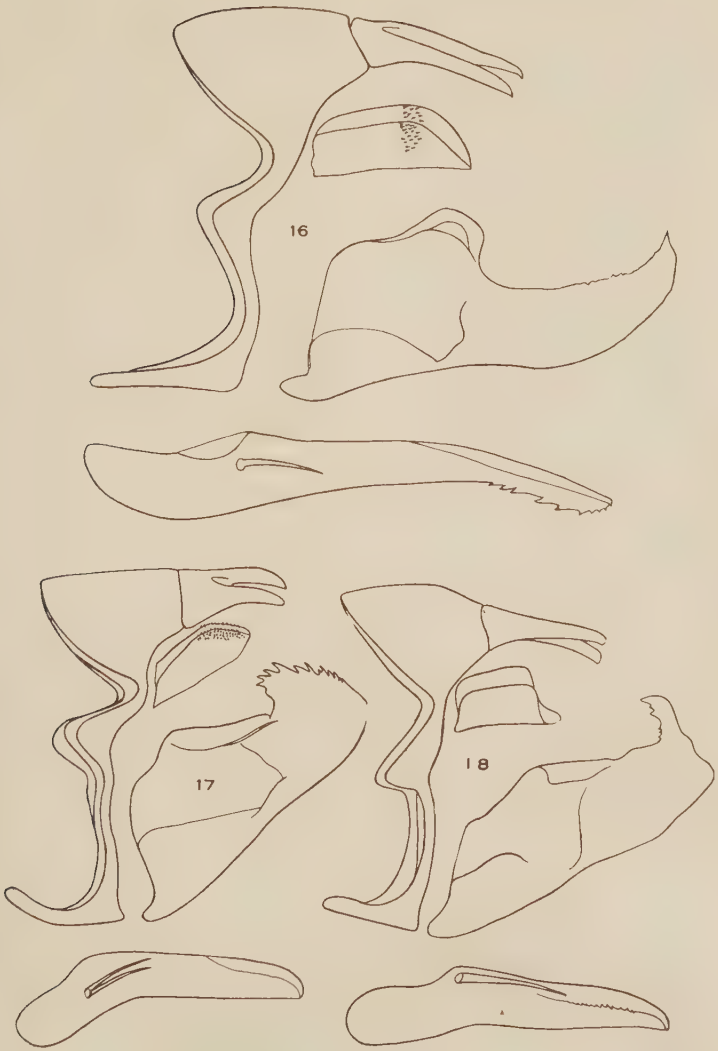

Fig. 16. *Telegonus colossus* Herrich-Schaeffer, Rio Songo, Bolivia. 17. *Telegonus mura* Williams, Manicore, Rio Madeira, Brazil. 18. *Telegonus parisi* Williams, Chapada, Matto Grosso, Brazil.

Telegonus colossus (Herrich-Schaeffer) (Fig. 16)

1874. *Eudamus colossus* Herrich-Schaeffer, Corres. Blat. Regensburg, XXXV, p. 172. (Tropical America.)
1922. *Thymele aulestes* Draudt, [not Cramer], Seitz's Macrolep., V, p. 866, pl. 168, d.

Colossus has been placed in the synonymy by Godman under *aulestes*. We have a series from Coroico and Rio Songo, Bolivia, which we cannot separate from *aulestes* on color or maculation but which are larger in size. The valvae are shaped differently from those of *aulestes*, a sufficient difference in connection with the larger size to consider them distinct, I refer them to *colossus* of Herrich-Schaeffer. *Aulestes* expands 6 cm. (center of thorax to tip of primary 34 mm.) and *colossus* 7 cm. (center of thorax to tip of primary 40 cm.). These dimensions apply to the males and are very constant in our series of this species.

Telegonus briccius (Plotz)

1881. *Eudamus briccius* Plotz, Ent. Zeit. Stet., XLII, p. 504. (South America.)
1922. *Thymele briccius* Draudt, Seitz's Macrolep., V, p. 866, pl. 168, c.

There are three females in the Academy collection that I assign to this species, one Brazil, one Upper Amazon and one Sao Paulo, Brazil, (Pohl). These have a lighter shade of green on the base of the wings and on the disc of the inferiors; the body and head strongly green, and the inferiors below with a lighter shade of green than that of the associated species, with two darker, rather ill-defined bands. The spots agree with those of the Seitz figure. Another female from San Pedro Sula, Honduras, (Leinhart) agrees in the markings, but the green color is darker above and below.

Telegonus mura new species (Pl. XXV, fig. 1, and Fig. 17)

Size and shape of *aulestes*. Wings dark purple-brown. Considerable olive green hairs and scaling on the base of the primaries and entire secondaries, also on palpi, head, collar and body. Fringes gray-white at lower outer margin of primaries and between veins on secondaries. Below same shade of purple-brown with considerable olive green scaling on secondaries; bands hardly noticeable. The primaries without apical spots; with a discal row of spots, two minute at costa, a cellular rectangle, another removed outwardly, and a triangle towards the margin; these spots do not impinge on each other, they are separated by spaces and there is no extra discal spot as in *aulestes* and *colossus*.

Expanse 64 mm.; center of thorax to apex of primary 35 mm.; to anal of secondary 25 mm.

This species is close to *aulestes* and *colossus* from which it differs in the absence of the extra discal spot. The male genitalia show valvae differing considerably from those of either of the above mentioned species.

From one male, type; Manicore, Rio Madeira, Brazil, October, 1923.

Named for a tribe of Tupi Indians.

Telegonus parisi new species (Pl. XXV, fig. 6, and Fig. 18)

Size and shape of *aulestes*. Wings dark purple-brown, the base of the primaries and the entire secondaries with dark blue scales giving a blue-green luster, especially on the disc and lower portion of the secondaries; fringes gray between the veins on secondaries. Below the wings are purple-brown, the secondaries with scattered dark green scales leaving two indistinct bands. Some dark green on the palpi, head, collar and body above.

The primaries are without costal spots, with a discal band of hyaline spots, a dash at costa, a square cellular spot, a rectangular spot followed by a square spot towards the margin, over the rectangular spot a triangle resting on its costal margin.

Expanse 57 mm., center of thorax to apex of primary 32 mm, to anal angle of secondary 22 mm.

This species resembles *enotrus* but is larger. The male genitalia differ in the shape of the valvae, and the aedoeagus carries a single large thorn instead of two short ones as in *enotrus*.

From one male, type; Chapada, Matto Grosso, Brazil, (Smith) and one male paratype; Muzo, Colombia.

Named for a tribe of Arawak Indians.

Telegonus mephitis (Hewitson) (Fig. 19)

1876. *Eudamus mephitis* Hewitson, Ann. Mag. Nat. Hist., XVIII, p. 349. (Chiriqui.)

1881. *Eudamus dinora* Plotz, Ent. Zeit. Stet., p. 502. (Chiriqui.)

1893. *Thymele mephitis* Godman and Salvin, Biol. Cent. Amer., Rhop. II, p. 313, pl. 78, fig. 7, 8 (♂).

1922. *Thymele dinora* Draudt, Seitz's Macrolep., V, p. 866, pl. 163, a, b.

We have a male from Chiriqui which corresponds with the Godman and Salvin figure, except that it has but one apical dot on the left wing (two on the right). *Dinora* was placed under

mephitis by Godman and while Draudt's figure of *dinora* has four apical dots, in other respects it agrees with the Godman and Salvin figure, which shows three apical dots and a fourth one indicated above, but considerably removed and below the others.

The male genitalia differ from the typical species of *Telegonus* especially in the shape of the valvae. The three following species or forms are very closely allied to it.

Telegonus fulminans (Herrich-Schaffer) (Fig. 20)

1869. *Eudamus fulminans* Herrich-Schaffer, Corres. Blat. Regensburg, XXII, p. 172. (Locality?).

1922. *Thymele fulminans* Draudt, Seitz's Macrolep., v. p. 866, pl. 168, c.

We have a pair from Rio Songo, Bolivia which I take to be this species. It closely resembles *mephitis*, and Godman has placed *mephitis* under it, as has Draudt, but the latter has misidentified *mephitis*, erecting *dinora* in its place. There are four apical dots. It differs from *mephitis* in that the central spots of the discal band are narrow, the wings a trifle more rounded on their outer margin, and the anal angle slightly more pointed.

The male genitalia, very close in pattern to those of *mephitis*, seem to differ somewhat in the shape of the tegmen and the ornament at the end of the valve has an external upward, pointing hook that is absent in *mephitis*.

Telegonus pacasa new species (Pl. XXV, fig. 4, and fig. 21)

Size and shape of *aulestes;* wings above dark purple-brown with dark olive green hairs on the body and the base of the primaries and the base and inner portion of the secondaries; fringes white at the anal angle of the primaries and between the veins of the outer margin of the secondaries giving them a pronounced checkered appearance in contrast with the fringes of *fulminans*. A very small apical dot only (*fulminans* has four distinct spots), a discal band consisting of two apical dashes (the lower one just indicated), a large square cellular spot, a larger rectangle with a spur towards the lower outer angle and a triangle towards the margin. An extra discal spot in the shape of a crescent. Below dark purplish-brown without green scaling. On the secondaries there is an outer band consisting of whitish spots and scaling more pronounced towards the anal angle and a small whitish spot in the cell. Expanse 55 mm. From centre of thorax to tip of primaries 35 mm., to anal angle 27 mm.

The male genitalia seem to be identical with those of *fulminans* of which it may be but a racial form, but from it differs in the lack of prominent apical spots, the much larger discal spots and the prominent checkering of the fringes of the secondaries.

Described from one male; Coroico, Bolivia.

Named for a tribe of Aymara Indians.

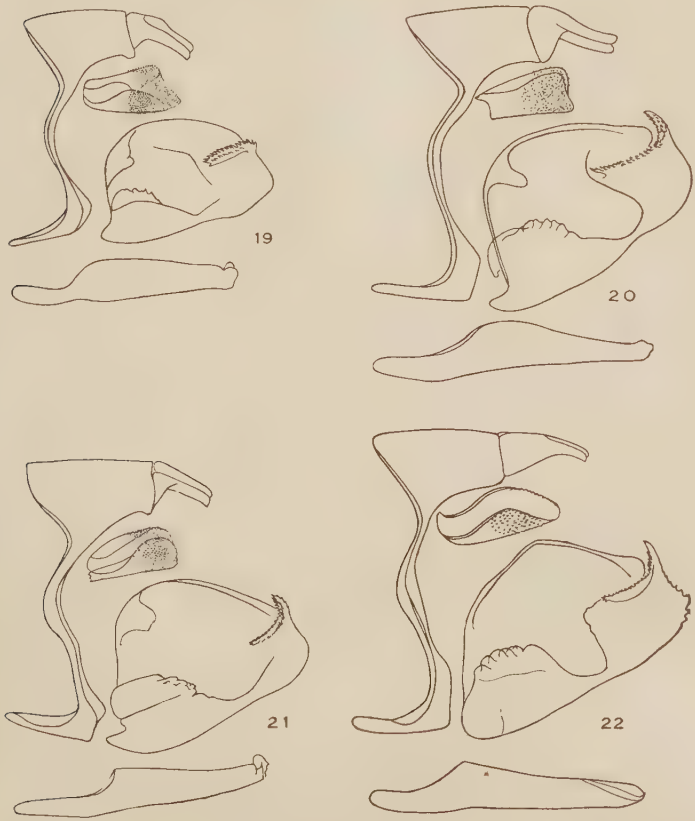

Fig. 19. *Telegonus mephitis* Hewitson, Chiriqui, Panama. 20. *Telegonus fulminans* Herrich-Schaeffer, Rio Songo, Bolivia. 21. *Telegonus pacasa* Williams, Coroico, Bolivia. 22. *Telegonus panche* Williams, Muzo, Colombia.

Telegonus panche new species (Pl. XXV, fig. 8, and fig. 22)

Similar in size and shape to *fulminans;* wings above purple-brown with an olivaceous shade caused by scattered green scales especially at the outer portion of the secondaries; hairs at base of primaries and secondaries and palpi, head and body, brown. Fringes white at lower angle of primaries and outer margin of secondaries. No apical spots, no costal dashes, a discal band of three hyaline spots, a rectangle in cell, a large one beyond, constricted centrally, and a triangle with the apex almost reaching the margin. A small extra-discal triangle. The cellular spot is located closer to the base of the wing than the corresponding spot in any of the allied species. Below, primaries same color and secondaries with more olive green. Hyaline spots repeated on primaries with some white scaling at the inner angle, secondaries with a whitish spot towards anal angle. Expanse 53 mm. From centre of thorax to tip of primaries 33 mm., to anal angle of secondaries 24 mm.

The male genitalia are very close to those of *fulminans* from which they differ in the shape of the projections of the uncus, the scaphium and somewhat in the valvae, which in *panche* are more roughened on the external rounded border and seem to lack the internal lobe on the dorsal border.

Described from one male, type; Muzo, Colombia.

Named for a tribe of Paniquita Indians.

Telegonus phalaecus (Godman and Salvin) (Fig. 34)

1893. *Thymele phalaecus* Goodman and Salvin, Biol. Cent. Amer., Rhop. II, p. 314, pl. 78, figs. 10, 11 and 12. (♂ genitalia), (Atoyac, Mexico; Guatemala; Costa Rica).

This species is like *anaphus* but it has a costal fold in the male. The male genitalia, like those of *anaphus* in other respects, have a quite different terminus to the valvae.

Records:—COSTA RICA: Juan Vinas (Calvert); Cartago (Gillott). HONDURAS: San Pedro Sula (Lienhart).

Telegonus anaphus (Cramer) (Fig. 23)

1779. *Papilio anaphus* Cramer, Pap. Exot., II, p. 126, pl. 178, fig. F. (Surinam.)

1893. *Telegonus anaphus* Godman & Salvin, Biol. Cent. Amer., Rhop. II, p. 305, pl. 77, fig. 10. (♂ genitalia).

1922. *Telegonus anaphus* Draudt, Seitz's Macrolep., V, p. 862, pl. 167, a.

Records:—DUTCH GUIANA: Paramaribo, (Mayo). COLOMBIA: Muzo; 260 miles N. E. of Bogota. ECUADOR: Huigra, (Rhoads). BOLIVIA: Coroico; Rio Songo. BRAZIL: Chapada, Matto Grosso, (Smith). PARAGUAY: Villa Rica, (Jorgensen). PANAMA: Chiriqui; Santiago de Veraguas, (Davies); Piedro Miguel and Gatun, Canal Zone, (Harrower). COSTA RICA: Cartago, (Calvert), (Gillott). GUATEMALA: Quirigua, (Rhoads). MEXICO: San Juan Evagelistes; Escuintla, Chiopas, (White).

Telegonus cubana (Mabille and Boullet) (Pl. XXI, fig. 5)

1912. *Telegonus alpistus* var. *cubana* Mabille and Boullet, Ann. Soc. Nat., Zool., XVI, p. 77. (Cuba.)

This insect is like *anaphus* in shape and color, except that the yellow of the lower wing is absent above, and only faintly indicated below; the fringe of the lower wing at the anal angle, and for some distance toward the costa, is yellowish, and the end of the abdomen is tipped with yellow as in *anaphus*. The ♂ genitalia seem to be identical with those of *anaphus*, of which *cubana* is, probably, an insular race.

Records:—CUBA. JAMAICA. ISLE ST. THOMAS. HAITI.

Telegonus galesus Mabille (Pl. XXIV, fig. 3, and fig. 24)

1888. *Telegonus galesus* Mabille, Le Natur., (2), x, p. 147, fig. 5. (Chanchamayo.)

I identify insects from the localities given below as this species. It is distinguished by the green body, and greenish reflection at base of wings, rather large size, dark, distinct bands in the same location as those of *anaphus*, and dark brown fringes.

Records:—BOLIVIA: Coroico: Rio Songo. COLOMBIA: Eastern part.

Telegonus galesus form **subflavus** new form (Pl. XXIV, fig. 4)

A specimen from Riobamba, Ecuador has the disc of the secondaries below strewn with lighter hairs, causing the bands to stand out more prominently, and below between the bands and just beyond the outer band the color is lighter with a decided yellowish tinge.

Type, ♂. Collection of The Academy of Natural Sciences of Philadelphia.

Telegonus jariba (Butler)

1870. *Aethilla jariba* Butler, Trans. Ent. Soc., London, 1870, p. 496. (Cuba.)
1874. *Aethilla jariba* Butler, Exot. Lep., p. 111, pl. 40, fig. 3.
1916. *Telegonus geronae* Holland, Ann. Carnegie Mus., x, p. 503. (Isle of Pines.)

The male is very dark, almost black, below the primaries somewhat lighter, the secondaries very dark. The veins seem so stand out prominently. The bands of the primaries are tlightly indicated only, and not noticeable in the secondaries. The collar and thorax are dark blue-green, and there are a few

blue-green hairs on the wings at the base; below there is no green on the body or the wings. Fringes only a shade lighter than the wings. The females are lighter in color, dark brown, and the bands are somewhat more prominent, otherwise similar to the males.

Record:—CUBA: Guantanamo (Ramsden).

Telegonus jariba race **jamaicensis** new race (Pl. XXII, fig. 6, and fig. 25)

Specimens of what I believe to be *jariba* from Cuna Cuna Pass, Jamaica (Robinson) differ from the Cuban specimens in that the ground color is lighter brown, the green is less blue in shade and more brilliant and more distributed, being on the palpae, head, collar, thorax, and some on the abdomen above; and on the thorax, femora and some on the abdomen below. There is also a considerable amount of brighter green and blue-green at the base of the primaries, and base and disc of the secondaries above, and some at the base of both wings below. The fringe of the outer margin of the secondaries is light gray-brown. The sexes are more nearly alike than those of Cuban *jariba*.

Type, ♂, allotype, ♀. Paratype, 1 ♀. Collection of The Academy of Natural Sciences of Philadelphia.

Telegonus xagua (Lucas) (Pl. XXIV, fig. 7, and fig. 26)

1856. *Eudamus xagua* Lucas, Sagra's Hist. Cuba, p. 627. (Cuba.)
1862. *Goniloba malefida* Herrich-Schaffer, Corres. Blat. Regensburg, XVI, p. 142. (Cuba.)
1881. *Goniloba jagua* Gundlach, Cont., I, p. 157.
1922. *Telegonus xagua* Draudt, Seitz's Macrolep., V, p. 864, pl. 167, d.

Xagua is dark brown above with palpi, head, thorax and abdomen and base of wings brilliant blue-green. Below only with a patch of blue towards the base of the primaries in the costal half of the wing. It is immaculate above but below there are two white spots more or less conspicuous on the middle of the costa of the primaries, dissappearing entirely in some specimens. The fringes are only a shade lighter than the dark brown ground color.

Telegonus antiquus Skinner (Pl. XXIV, fig. 8)

1920. *Telegonus antiquus* Skinner, Ent. News, XXXI, p. 133. (Santo Domingo.)
1924. *Telegonus domingensis* Joicey and Talbot, The Ent., LVII, p. 39. (Santo Domingo.)

Fig. 23. *Telegonus anaphus* Cramer, Villa Rica, Paraguay. 24. *Telegonus galesus* Mabille, East Colombia. 25. *Telegonus jariba* race *jamaicensis* Williams, Jamaica. 26. *Telegonus xagua* Lucas, Cuba. 27. *Telegonus habana* Lucas, Cuba. 28. *Telegonus alardus* Stoll, Cariaquito, Venezuela.

Domingensis seems to be a pure synonym, probably because the authors were not familiar with the previous American description.

Antiquus is similar to *xagua* except that the narrow fringes are white and there is some white on secondaries on the outer margin below not however as a distinct band as in *habana*.

The type and a paratype are in the Academy collection.

Telegonus habana (Lucas) (Fig. 27)

1856. *Eudamus habana* Lucas, Sagra's Hist. Cuba, p. 624. (Cuba.)
1922. *Telegonus habana* Draudt, Seitz's Macrolep., v, p. 864, pl. 167, d.

Habana is like *antiquus* above but has long white fringes. Below it has white scales at the apex and on the outer margin and a narrow band on the outer margin of the secondaries.

Records:—CUBA: Guantanamo (Ramsden).

Telegonus alardus (Stoll) (Fig. 28)

1791. *Papilio alardus* Stoll, Sup. Cramer's Exot. Lep., p. 171, pl. 39, fig. 7. (Surinam.)
1893. *Telegonus alardus* Godman and Salvin, Biol. Cent. Amer., Rhop. II, p. 308, pl. 77, fig. 19. (♂ genitalia.)
1918. *Telegonus fabrici* Ehrmann, Lepidoptera, II, p. 29. (♂ Venezuela.)
1922. *Telegonus alardus* Draudt, Seitz's Macrolep., v, p. 864, pl. 167, c.

Records:—COLOMBIA: Muzo. VENEZUELA: Cariaquito, (Brown). BRAZIL: Upper Amazon. BOLIVIA: Coroico; Rio Songo, Huancabamba. PANAMA: Gatun, Canal Zone, (Harrower). COSTA RICA: Cartago, (Gillott); Alajuela, (Calvert).

Alardus is larger than *habana* and the bands are conspicuously whiter and broader. The anal angle of the secondaries is more acute. *Antiquus*, *habana* and *alardus* are evidently closely related. Dr. Holland states in his recent paper on the Ehrmann Collection that *fabrici* is a typical male of *alardus*.

Telegonus chiriquensis Staudinger (Fig. 29)

1875. *Telegonus chiriquensis* Staudinger, Verz. Zool. Bot. Ges. Wien., XXV, p. 111. (Chiriqui.)
1876. *Eudamus meretrix* Hewitson, Ann. Mag. Nat. Hist., (4), XVIII, p. 350. (Ecuador.)
1882. *Aethilla weymeri* Plotz, Berlin Ent. Zeit., XXVI, p. 257. (Locality?.)
1888. *Telegonus chiriquensis* Staudinger, Exot. Tagf., p. 290, pl. 98, (♂).
1922. *Telegonus chiriquensis* Draudt, Seitz's Macrolep., v, p. 863, pl. 167, b.

Records:—PANAMA: Chiriqui. COSTA RICA: Peralta, (Calvert). MEXICO: Palenque. COLOMBIA: Muzo.

Telegonus chiriquensis form **grullus** (Mabille)

1888. *Thymele grullus* Mabille, Le Natur., (2), x, p. 147, fig. 7. (Chiriqui.)
1893. *Telegonus grullus* Godman and Salvin, Biol. Cent. Amer., Rhop. II, p. 308, pl. 77, figs. 17, 18, (♂).

Some specimens of *chiriquensis* have a white instead of a yellow marginal band on the secondaries below. I believe them to be only a varietal form.

Records:—PANAMA: Gatun, Canal Zone, (Harrower). COLOMBIA: Muzo.

Telegonus chiriquensis form **godmani** new form

1893. *Telegonus chiriquensis* Godman and Salvin, Biol. Cent. Amer., Rhop. II, p. 308 (part) pl. 77, figs. 15, 16, (♂).

The figures represent a form of *chiriquensis* in which the typical yellow of the outer margin of the secondaries below, is replaced by light brown. In this respect it is like *elorus*. There are intergrades between it and typical yellow, and the white of form *grullus*.

Record:—NICARAGUA: Great Falls, Pis Pis River near Eden, (Huber).

Telegonus elorus (Hewitson)

1867. *Eudamus elorus* Hewitson, Desc. Hesp., p. 10. (Locality?.)
1882. *Eudamus blasius* Plotz, Ent. Zeit. Stet., XLIII, p. 91. (America.)
1920. *Telegonus blasius* (*subblasius*) Strand, Archiv. Naturges. XXVI, Abt. A, (7), p. 143. (Misiones, Argentine.)
1922. *Telegonus elorus* Draudt, Seitz's Macrolep., V, p. 863, pl. 167, b.

According to Godman who saw the type, it is distinguished from *chiriquensis*, which it otherwise resembles, by the outer band of the primaries, below, being continuous and parallel with the outer border and not broken. On the secondaries, below, the color of the outer marginal band is gray [light brown] which in the typical *chiriquensis*, is yellow. Both Godman and Draudt put *blasius* as synonymous with *elorus*, and I agree with the latter, in placing *subblasius* in the synonymy also.

Record:—1 ♀, Brazil.

Telegonus creteus (Cramer) (Fig. 30)

1782. *Papilio creteus* Cramer, Pap. Exot., III, p. 163, pl. 284, figs. C. D., [♂], (Surinam).
1782. *Papilio parmenides* Cramer, Pap. Exot., IV, p. 144, pl. 364, figs. E. F. [♀].

I agree with Godman and Salvin in considering *parmenides* to be the female of *creteus*. Some females, however, have more or less of a white patch in the disc of the primaries, above.

Records:—PANAMA: Gatun, Canal Zone, (Harrower). ECUADOR: Huigra, (Rhoads). BRAZIL: St. Catherines; Chapada, Matto Grosso, (Smith). PARAGUAY: Villa Rica, (Jorgensen).

Telegonus creteus form **hopfferi** (Plotz)

1882. *Eudamus hopfferi* Plotz, Ent. Zeit. Stet., XXIV, p. 90. (Locality?.)
1922. *Telegonus creteus hopfferi* Draudt, Seitz's Macrolep., V, p. 863, pl. 167, d, e.

This is a form in which the costal margin of the secondaries, below, is bordered with white, similar to this character in fulgerator, It is variable in intensity, and sometimes there is white along the costal margin of the primaries below. It does not seem to be a racial character. The male genitalia are the same as those of *creteus*.

Records:—PANAMA: Santiago de Veraguas, (Davies). BRITISH HONDURAS: Corozal. MEXICO: Trexola; Colima. FRENCH GUIANA.—BOLIVIA: Coroico; Rio Songo. BRAZIL: Chapada, Matto Grosso, (Smith).

AGUNA new genus

Reference has been made above to *Papilio talus* the type of the genus *Telegonus*. *Papilio coelus*, associated with talus in the literature differs in the male genitalia to such an extent that the relationship is doubtful and I cannot assign it to *Telegonus* or any of the allied genera. I therefore propose a new genus, *Aguna* with *Aguna camagura* = *Eudamus camagura* Williams as the genotype and to include *Papilio coelus* Cramer, *Thymele ganna* Maschler, *Goniurus gideon* Plotz, *Goniurus albistria* Plotz, *Hesperia metophis* Latrielle and *Eudamus asander* Hewitson.

In this genus the secondaries below have a distinct silver band (as in *ganna*, *asander* form *scheba* etc.) which as it disappears turns to a lilac color with a distinct inner margin and shading off into the ground color towards the outer border (*camagura*, *asander* form *panthius* etc.).

The pattern of the hyaline spots on the primaries is similar in all these species namely, a discal row, an extra discal spot, and an apical row, the lower ones removed towards the apex. They are provided with long tails or short lobes at the anal angle. Those which I have included in the genus all have a costal fold in the male.

Asander which I have removed from *Epargyreus* on the male genitalic characters also differs in that the silver band when present (form *scheba*) is distinct, disappearing into a lilac band rather sharply defined inwardly (form *panthius*) while in the silvered species of *Epargyreus* the band is composed of a spot which becomes elongated or a series of spots which coalesce.

As to the male genitalia, all have a long, narrow tegmen terminating in a relatively short bifid uncus, and a correspondingly long narrow scaphium. The aedoeagus carries a floating bundle of spines fused at their base and there is considerable ornamentation at the extremity. The valvae, which seem to be as a rule the most variable organs of the male genitalia in different species of the same genus, show a certain similarity in being rather broad and short but vary considerably in their terminal ornamentation.

Aguna coelus (Cramer) (Fig. 31)

1782. *Papilio coelus* Cramer, Pap. Exot., IV, p. 102, pl. 343, figs. C. D. [Locality?].
1867. *Eudamus aurunce* Hewitson, Desc. Hesp., p. 9. (Amazon.)
1875. *Eudamus aurance* Hewitson, Exot. But., V, text, & pl. Eudamus III, fig. 20.
1893. *Goniurus coelus* Godman and Salvin, Biol. Cent. Amer., Rhop. II, p. 287, pl. 76, fig. 1. (♂ genitalia).
1912. *Goniurus coelus* Mabille & Boullet, Ann. Soc. Nat., Zool., (9), XVI, p. 60.
1922. *Goniurus coelus* Draudt, Seitz's Macrolep., V, p. 860, pl. 166, c.

I identify Cramer's *coelus*, as distinguished from the following species as having a silver band on the secondaries somewhat broadened centrally and with a very slight inward hook at its lower extremity. *Aurunce* Hewitson I believe to be a synonym and I believe Godman and Salvin have correctly identified it in their figure of the male genitalia.

Record:—COLOMBIA: Muzo.

Aguna gideon (Plotz) (Pl. XXV, fig. 9 and fig. 32)

1880. *Goniurus gideon* Plotz, Bull. Soc. Moscow, IV, p. 22. [Locality?.]

The key used by Plotz to separate this species from *coelus* is very unsatisfactory but it indicates that the spots of the primaries are smaller and the silver band of the secondaries narrower. Therefore, I assign the specimens I have before me from Panore, Brazil and one from Colombia, (Peale Collection) to

this name. The male genitalia differ from those of *coelus* strikingly in the valvae. They are, however, very close to but not identical with those of *ganna* Moschler, the differences being in the shape of the termination of the scaphium and the aedoeagus principally. *Gideon* has shorter tails than *ganna*, but in other respects it is very close.

Aguna asander (Hewitson) (Fig. 33)

1867. *Eudamus asander* Hewitson, Desc. Hesp., p. 9. (Amazon [Ega].)
1875. *Eudamus asander* Hewitson, Exot. But., v, text and pl. Eudamus III, fig. 24.
1893. *Epargyreus asander* Godman & Salvin, Biol. Cent. Amer., Rhop. II, p. 300, pl. 77, fig. 4. (♂ genitalia.)
1912. *Epargyreus asander* var. *euthymides* Mabille and Boullet (Plotz ms.), Ann. Soc. Nat., Zool. XVI, p. 65.
1922. *Epargyreus antaeus* Draudt, [not Hewitson], and *Epargyreus asander* Draudt, Seitz's Macrolep., v, p. 861, pl. 166, f.

As stated by Godman & Salvin, *asander* is very variable on the secondaries below, typical specimens having a rather large white band, broader below and enclosing a small dark dash above, the outer margin is broadly lilac. The insect figured as *antaeus* by Draudt has the typical band, while that figured as *asander* has the band somewhat reduced and modified and may be the *euthymides* (Plotz drawing), mentioned by Mabille and Boullet. When the band becomes reduced to a narrow straight stripe it is variety *scheba*, and when the band is absent but replaced by the lilac basal color which extends inwardly to a line which would be the inner margin of the band, it is variety *panthius*. These forms merge one into the other, the white in the females seeming to be as a rule less conspicuous.

The male genitalia are of the same general pattern as those of *coelus*, the valve has more elaborate external ornamentation including an interior arm with terminal teeth. They seem to be reasonably constant in the several forms.

Records:—BRAZIL: St. Catherines. MEXICO: Colima.

Aguna asander form **scheba** (Plotz)

1882. *Eudamus scheba* Plotz, Stett. Ent. Zeit., XLIII, p. 94. (South America.)
1922. *Epargyreus asander* form *scheba* Draudt, Seitz's Macrolep., v, p. 861, pl. 161, f, g.

Records:—PARAGUAY: Villa Rica, (Jorgensen). COLOMBIA. JAMAICA.

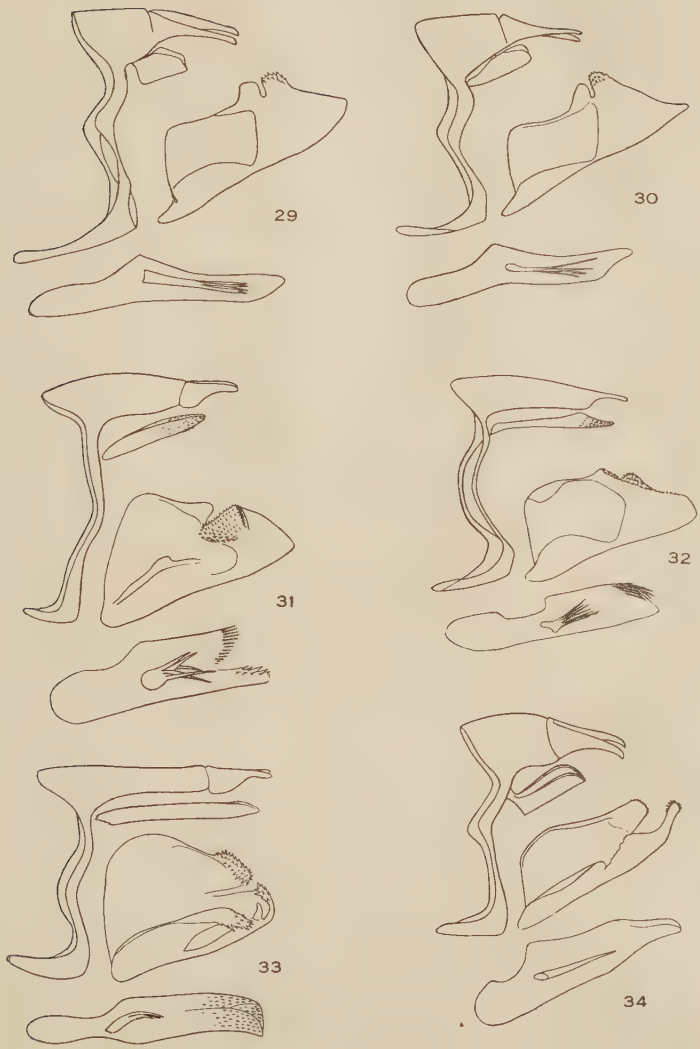

Fig. 29. *Telegonus chiriquensis* Staudinger Panama. 30. *Telegonus creteus* Cramer, Gatun, Canal Zone, Panama. 31. *Aguna coelus* Cramer. Muzo, Colombia. 32. *Aguna gideon* Plotz, Colombia. 33. *Aguna asander* Hewitson, Colima, Mexico. 34. *Telegonus phalaecus* Godman and Salvin, Cartago, Costa Rica.

Aguna asander form **panthius** (Herrich-Schaffer)

1869. *Eudamus panthius* Herrick-Schaffer, Corres. Blat. Regensburg, XXIII, p. 186. (Tropical America.)
1904. *Epargyreus arsaces* Mabille, Wytsman's Gen. Ins. Hesp., p. 24. (Isle St. Thomas.)
1922. *Epargyreus asander* form *panthius*, Draudt, Seitz's Macrolep., V, p. 861, pl. 166, f.

Mabille and Boullet[3] sink *arsaces* Mabille to *panthius*, and redescribes *arsaces* (Mabille) as a variety of *asander*, adding to the locality above "Martinique." It is possible that a series from the type locality will show sufficient differences from the continental form to warrant the retention of the name *arsaces* as an insular race.

Records:—PANAMA: Santiago de Veraguas, (Davies). HONDURAS: San Pedro Sula, (Lienhart). MEXICO: Colima.

Attention is called to my first paper[4] in which is figured the four other species I have assigned to this genus as well as their male genitalia namely *Aguna ganna*, *albistria*, *metophis* and *camagura*.

Polygonus lividus Hubner

1775. *Papilio amyntas* Fabricius, [not Poda, 1761]. Syst. Ent., p. 533,
1816–20. *Polygonus lividus* Hubner, Saml. Exot. Schm., II, pl. 144.
1823. *Hesperia savigny* Latrielle, Enc. Meth., IX. p. 741.
1888. *Pamphila amyntas* Staudinger, Exot. Schm., p. 297, pl. 99, ♂.
1893. *Acolastus amyntas* Godman and Salvin, Biol. Cent. Amer. Rhop. II, p. 304, pl. 77. fig. 9. (♂ genitalia.)
1911. *Eudamus* (*Acolastus*) (*Erycides*) *amyntas* Skinner, Trans. Am. Ent. Soc., XXXVII, p. 200, pl. 10.
1922. *Acolastus amyntas* Draudt, Seitz's Macrolep., V, p. 862, pl. 146 g.

There is considerable variation in this insect and eventually racial names may be applied, especially to the Island forms.

Records:—FLORIDA: Miami, (Laurent); Key West (Morrison). MEXICO: Colima. HONDURAS: San Pedro Sula, (Lienhart). CUBA: Guantanamo, (Ramsden). HAITI: Port au Prince; Samana (Abbott). SANTO DOMINGO (Frazer). JAMAICA. BRAZIL: Chapada, Matto Grosso, (Smith); Rio Janeiro; Sao Paula, (Pohl); Amazons. PARAGUAY: Villa Rica, (Jorgensen).

[3] Ann. Soc. Nat. Zool., (9), XVI, pp. 64, 69, 1912.
[4] Trans. Am. Ent. Soc., LII, pp. 78–81, 1921.

Polygonus lividus race **arizonensis** (Skinner)

1911. *Erycides amyntas arizonensis* Skinner, Trans. Am. Ent. Soc., XXXVII, p. 209, pl. 10.

The type and six paratypes, all males, from Florence, Arizona, (Biederman) are in the Academy collection.

Proteides mercurius (Fabricius)

1782. *Papilio idas* Cramer, Pap. Exot., III, p. 118, pl. 260 figs. A, B., [not Linnaeus, 1761]. (Surinam.)

1787. *Papilio mercurius* Fabricius, Mant. Ins., p. 86; Ent. Syst., III, p. 333, 1793. ("Caiennae.")

1855. *Papilio idas* Sepp, Sur. Vlind., III, p. 231, pl. 104.

1922. *Proteides idas* Skinner and Williams, Trans. Am. Ent. Soc., XLVIII, p. 113, fig. 6. (♂ genitalia.)

1922. *Proteides idas* Draudt, Seitz's Macrolep., V, p. 861, pl. 166, d.

This species is also somewhat variable on the mainland and very much so in the Antilles where three forms have been given names.

Records:—MEXICO: Escuintla, Chiopas, (White). COSTA RICA: Cartago, (Gillott). HONDURAS: San Pedro Sula, (Lienhart). PANAMA: Santiago de Veraguas, (Davies). COLOMBIA: Puerto Atlantico, (Rehn). BRAZIL: Chapada, Matto Grosso, (Smith); Sao Paula, (Pohl). PERU: Madre de Dios. BOLIVIA: Coroico; Rio Songo. PARAGUAY: Villa Rica, (Jorgensen).

Proteides mercurius race **sanantonio** (Lucas)

1856. *Eudamus san-antonio* Lucas, Sagra, Hist. Cuba. VII, p. 626.

1816. *Proteides idas* var. *san-antonio* Holland, Ann. Carnegie Mus., X, p. 502, pl. 31, figs. 1, 2. (Neuva Gerona, Isle of Pines).

In our series from Cuba including some from Guantanamo (Ramsden) the hyaline spots are greatly reduced. One is immaculate except for a single apical dot, and a dot on the costa, in some there are one or two apical dots, the costal and terminal dot of the mesal band only and in a few an additional mesal dot and some showing the extra mesal dot.

We have a specimen from Santo Domingo (Frazer) and from the island St. Thomas, resembling the Cuban race.

Proteides mercurius race **pedro** (Dewitz)

1877. *Goniloba idas* var. *Pedro* Dewitz, Ent. Zeit., Stet., XXXVIII, p. 242. (Porto Rico.)

1882. *Eudamus gundlachi* Plotz, Ent. Zeit. Stet., XLIII, p. 92. (Porto Rico.)

1884. *Proteides angasi* Godman and Salvin, Proc. Zool. Soc. London, 1884, p. 318, pl. 25, fig. 2. (Dominica.)

1922. *Proteides idas* form *gundlachii* Draudt, Seitz's Macrolep., V, p. 861, pl. 166d.

Dewitz described *pedro* as differing from *mercurius* in that it is brown instead of ash gray below. We have a specimen from Dominica (Geddes) which I would call intermediate between the figures of *gundlachi* in the Seitz work and *angasi* of Godman and I am of the belief that the above names are synonymous representing the southern insular race which is typical above but brown below.

Proteides mercurius race **jamaicensis** Skinner

1920. *Proteides jamaicensis* Skinner, Ent. News., XXXI, p. 133. (Jamaica.)

In this race from Jamaica the upper side is rather like typical *mercurius* but the lower side of the wings have a purplish tint in place of the white-ash of the mainland form and the brown of the Dominica form.

EXPLANATION OF PLATES

Plate XXIV

Fig. 1.—*Epargyreus tmolis* Burmeister, ♂, Quilmes, near Buenos Aires, Argentine.
Fig. 2.—same, ♀.
Fig. 3.—*Telegonus galesus* Mabille, ♂, Rio Songo, Bolivia.
Fig. 4.—*Telegonus galesus* form *subflavus* Williams, type, ♂, Riobamba, Ecuador.
Fig. 5.—*Telegonus cubana* Mabille and Boullet, ♀, Jamaica.
Fig. 6.—*Telegonus jariba* race *jamaicensis* Williams, allotype, ♀, Cuna Cuna Pass, Jamaica.
Fig. 7.—*Telegonus xagua* Lucas, ♂, Guantanamo, Cuba.
Fig. 8.—*Telegonus antiquus* Skinner, type, ♂, Santo Domingo.

Plate XXV

Fig. 1.—*Telegonus mura* Williams, type, ♂, Manicore, Rio Madeira, Brazil.
Fig. 2.—*Eudamus doryssus* form *tenuis* Williams, type, ♂, Rio Janairo, Brazil.
Fig. 3.—*Eudamus doryssus* form *interruptus* Williams, type, ♂, San Pedro Sula, Honduras.
Fig. 4.—*Telegonus pacasa* Williams, type, ♂, Coroico, Bolivia.
Fig. 5.—*Telegonus tucuti* Williams, type, ♂, Gatun, Canal Zone, Panama.
Fig. 6.—*Telegonus parisi* Williams, type, ♂, Chapada, Matto Grosso, Brazil.
Fig. 7.—*Telegonus christyi* Sharpe, ♂, Santo Domingo (Paratype of *augustus* Skinner).
Fig. 8.—*Telegonus panche* Williams, type, ♂, Muzo, Colombia.
Fig. 9.—*Aguna gideon* Plotz, ♂, Panore, Brazil.

WILLIAMS—NEOTROPICAL HESPERIOIDEA

WILLIAMS—NEOTROPICAL HESPERIOIDEA

THE MATING OF THE PSYCHIDAE (LEPIDOPTERA)

BY FRANK MORTON JONES

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The history of our knowledge of the basket-worms or bag-worms, the Psychidae, is no exception to that of any of our well-marked insect groups: first encumbered with much of the legendary and the mythological, there gradually emerged that more definite knowledge based upon direct personal observation, which constitutes the real beginnings of our modern scientific literature. The phenomenon of parthenogenesis, exhibited by the wingless females of a number of species in this family, seems to have had its first recognition in the writings of Pallas (1767), who records of two of them that "truly (the female) of both brings forth fertile eggs, without having mated with males."

Schrank (1802) first separated these insects by name (his genus *Psyche*) from those larger assemblages, *Tinea*, *Bombyx*, *Phalaena*, under which earlier authors had grouped such diverse forms; he described the wingless female as "Ein blosser Eyersack" (a mere bag of eggs), and concluded his characterization of the genus with "Aus den Eyern kommen, auch ohne Begattung, lebendige Jungen aus, die aber nicht fortwachsen" (out of the eggs, even without coition, come living young, which however do not continue to grow).

In subsequent literature, these statements were repeated and amplified by some authors; by others the occurrence of parthenogenetic reproduction was positively denied. Siebold (1856)[1] established beyond reasonable doubt that the two genera now designated as *Solenobia* and *Apterona* include female insects, apterous, but in sexual structure conforming to the lepidopterous model, possessing copulative pouch and seminal receptacle, depositing true eggs whose shells exhibit typical

[1] Wahre Parthenogenesis bei Schmetterlingen und Bienen, Leipzig, 1856. An English translation by Dallas, London, 1857.

micropyles, and which go through generation after generation without the intervention or even the appearance of a male.

Seiler (1917–1920), in a series of papers under the title, *Geschlechtschromosomen-Untersuchungen an Psychiden*, fully confirms the parthenogenetic reproduction of *Solenobia*, and incidentally shows that in some localities, of this genus females only are produced, in other localities males and females appear in numbers approximately equal. He concludes that in these species the bisexual strain is being slowly eliminated. The females of the parthenogenetic strain commence egg-laying immediately upon emergence; those of the bisexual strain await the coming of the males, before oviposition. If we err in referring to the same species these parthenogenetic Psychids and the bisexual forms whose females seem identical, at least we have found no ground upon which they may be referred to separate genera. That is, Psychids of the same species (or genus), at a given time and place, may be exclusively parthenogenetic; or at another time or place, they may usually if not invariably require a normal mating for the production of fertile eggs.

The well-authenticated examples of parthenogenetic Psychids, in the main, belong to the so-called "lower" or "Micro-Psychids"—insects whose females, though wingless, yet possess functional legs, eyes, antennae, and which leave their pupae and bags before mating or oviposition. Our recognized North American Psychids include only one representative of these groups—*Solenobia walshella* Clemens. Both sexes of this insect are well known, and its literature gives no hint of a parthenogenetic habit. Our own observations in several localities indicate the appearance of males and females in approximately equal numbers, and that the emerging female, awaiting a male, sits upon her cocoon for days, and eventually dies in that position without ovipositing, if no male appears. By analogy with its European allies, the discovery of isolated colonies of parthenogenetic females of *walshella* is always a possibility.

Although the special interest attaching to the mode of life of the Psychids, and the economic importance of some of them, have resulted in an extensive literature of the group, so contradictory have been the published statements in regard to these insects that it is impossible to give even the barest outline

of their life-cycle and behavior, without to some degree coming into conflict with this literature. The life of our most familiar species, *Thyridopteryx ephemeraeformis* Haworth, distributed as a shade-tree pest from Massachusetts to central Texas, may be briefly summarized thus:

The young larvae, on hatching from the eggs contained in the pupa-shell of the female, which in turn is still enclosed in the larval basket or bag, on reaching the open air immediately construct for themselves each a portable protecting case of silk and vegetable fragments; this they enlarge from time to time, never leaving it completely throughout their larval and pupal life. This larval case or "bag" is open at both ends; the upper opening, from which the larva partially emerges to feed and to attach, detach, and alter its bag, is the larger; the lower opening is narrow and of soft flexible texture, capable of being stretched from within for partial exit, but collapsed and difficult of access from without. The bags of the males (Plate XXVI), in size, shape, and ornamentation, are usually distinguishable from those of the females (Plate XXVII). When ready to pupate, the larva makes a strong silken attachment of the upper end of its case to some suitable support, permanently closes this opening, reverses its position in the bag, and pupates head downward. The male pupa shows wing-covers, legs, antennae, eyes—all the typical structures of the lepidopterous pupa; the female pupa is maggot-like in form, and none of these organs are plainly indicated. In emergence, the male pupa pushes part way out of the narrow lower end of the bag, and thus suspended, by dehiscence of the pupa-shell the male escapes and flies away; the female, when mature, without materially altering her position in the larval case, splits her pupa-shell in a T-shaped slot at the head end, and there awaits the approach of the male. The female (Plate XXVIII) is soft, whitish, destitute of wings, functional eyes, legs, antennae, and is almost naked; through her transluscent skin the convolutions of her egg-packed ovarian tubes may be observed, almost filling her body; she seems, indeed, "Ein blosser Eyersack." The male finding and identifying the receptive female by scent, introduces his abdomen into the concealed lower opening of her larval case, and after a brief stay in this position, withdraws

his body and flies away. The female then proceeds to fill the uppermost portion of her pupa-shell with eggs (Plate XXVIII), retreating downward as this is accomplished; at its completion (the pupa-shell about three-fourths full) she tamps in a plug of protective down from her own body, and in her greatly shrunken and weakened condition, presses her way out and falls to the ground to die.

Even with the recognition, however, that all of the "Macro-Psychids" possess both males and females, and that an apparent mating usually takes place,—the male outside, the female inside her larval case,—there continues to be great disparity of statement, especially with reference to the mating and the egg-laying of these insects. The most casual observation indicates the presence of the male pupa, head downward in its bag, from which position it pushes out in emergence. How then could a female, her head thus directed toward the only opening of her larval case, mate with a male which remains outside that case? Seitz[2] easily disposes of the problem by stating that "the ♀ larva does not turn round for pupation, the head of the chrysalis remaining directed towards the tightly closed mouth of the case." Froggatt[3] makes a similar assertion of two Australian species. These statements are not true of the Psychids in general, nor are they true of any species we know in life. When Psychid cases are changed in position after their larvae have affixed them for pupation, sometimes these larvae fail to turn toward the open end, or having turned, reverse their position once more;[4] and very rarely this happens with our own *ephemeraeformis* in the open, always resulting in the death (without progeny) of the enclosed insect.[5]

Often associated with the statement that the head of the female is directed toward the closed and fixed end of her case, is the belief that she never leaves her pupa-shell, but that the eggs hatch within her body, the young creeping out through its walls. Froggatt[3] makes this assertion of the two Australian species he describes; Fabre[6] gives a detailed account of the

[2] Macrolepidoptera of the World, Introduction to Psychidae, p. 352, 1912.
[3] Australian Insects, 244, 1907; Forest Insects of Australia, p. 154–5, 1923.
[4] Burrows, The Ent. Record, XXXVI, p. 98, 1924.
[5] See Riley, Proc. Biol. Soc. of Washington, II, p. 83, 1884.
[6] The Life of the Caterpillar, de Mattos trans., p. 215, 1916.

shrinking and drying of the body of the female, to form an inner lining to her pupa, and the hatching of the young from this double receptacle; John B. Smith[7] says, "The eggs . . . frequently . . . mature within the abdomen without being laid . . . the young caterpillars hatch and eat their way through the eggshell, the mother womb, and out of the old bag"; and Macfarland[8] asserts this specifically of *ephemeraeformis*, explaining that "the eggs remain in the ovaries of the dead female during winter."

This does not exhaust the explanations advanced with reference to the mating and egg-laying of the Psychids; for Bruand[9] says, of those species with vermiform females, that when ready for mating the female turns around and presents her anal extremity at the opening of her case; Westwood[10] expresses the belief that in *Oiketicus* the female, in mating, turns her body around within her pupal skin; and Moore[11] asserts of an Indian species that "The pupa before emergence of imago inverts its position within the case."

Denis & Schiffermüller[12] after prolonged observation of *Psyche viciella*, seriously conclude that this species reverses the usual course of nature and that it possesses no female, the female larva transforming into a brown shell full of eggs which hatch without fertilization—a theory which deserves reference only because it reappears a hundred years later in the literature of our own most abundant species, *ephemeraeformis*, and because too it somewhat foreshadows the results of a modern study of an allied species, which indicates the possibility that we may have misunderstood entirely the significance of the apparent matings of these insects. In an able and almost exhaustive study of an African Psychid,[13] Hardenberg,[14] after

[7] Ent. News, IV, p. 4, 1893.

[8] Jour. Trenton Nat. Hist. Soc., I, p. 2, 1886.

[9] Essai Monographique sur la Tribu des Psychides, 1852.

[10] Trans. Ent. Soc. Lond., 3rd Ser., II, p. 103, 1865.

[11] Jour. Asiatic Soc. of Bengal, LIX, p. 264, 1890.

[12] Syst. Verz. Schmetterl. Wienergegend, p. 292–296, 1776.

[13] *Acanthopsyche junodi* Heylaerts, a species superficially so nearly identical with *ephemeraeformis* that in the British Museum collection the two species were long confused.

[14] Annals Natal Museum, III, p. 680, 1917.

keeping thousands of the insects in captivity, and having many more under observation in the open, asserts the belief that no true mating ever occurs; that the male, assuming on the case of the female the attitude which has been construed as a mating attitude, fertilizes the eggs by irrigation, after they have been deposited in the female pupa-shell.

Fig. 1. Part of Guilding's plate of *Oiketicus kirbyi*, showing his version of the extrusible male organ.

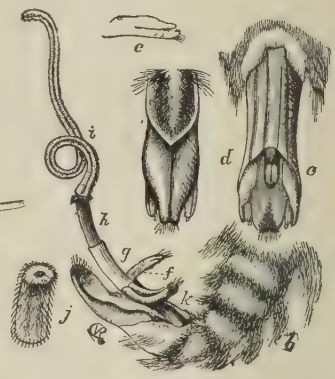


Fig. 2. Part of Riley's drawing of the male abdomen of *ephemeraeformis*.

There remains one additional explanation which is fully in accord with the easily-observed phenomena of the matings of these insects, and which seems also to be well supported by an examination of the structure of the male. For our larger Psychids of the western hemisphere, this originated one hundred years ago with Landsdown Guilding's description[15] of *Oiketicus kirbyi*, an insect which had been under his observation in the West Indies for nine years before he felt sure enough of his own interpretation of what he saw, to make this public. Though he consulted Kirby, Guilding evidently knew nothing of the earlier literature of European Psychids. After he had discovered the grub-like female of *kirbyi*, head downward in her split pupa-shell, he continued to be puzzled by the apparent impossibility of a mating while she occupied this position; then by accident he detected in the male genitalia a thread-like body, as long as the abdomen (Fig. 1), apparently extrusible,

[15] Trans. Linn. Soc. of London, June 6, 1826.

and which he most naturally interpreted as the agency by which a mating with the concealed female is possible. From the structure of this organ, which he describes as "Glans penis, extensilis, non retractilis (?), spinulis recurvis sparsis," he believed that the male necessarily perishes after a single mating.

With frequent references to Guilding's text and illustrations, Berg[16] describes the mating of an insect identified as *Oiketucus kirbyi* (since referred to *Oiketicus geyeri*), as observed by himself and Burmeister in Argentina; he relates in detail the arrival of the excited male, its prolonged struggles to insert its abdomen in the larval case of the female, the quick killing of both sexes, by which he determined that the female *had not* turned around in her pupa-shell to facilitate the mating, and he ascribes the ability of the male to consummate the mating, to the flexible retrorse-haired organ, 19 mm. in length, which from the lower opening of the sack (in his words) "tongues its way quickly to meet the female." This is substantially identical with C. V. Riley's often-quoted description of the mating of *ephemeraeformis*, which, in its most circumstantial version, first appeared in Scientific American Supplement, Sept. 28 and Nov. 28, 1878. In this same journal (August 24, 1878), under the title "*A Fatherless and Motherless Race,*" William Hamilton Gibson had published his conclusions, based upon twelve years of puzzled study of this insect in Brooklyn, New York. Failing completely in his search for the female, his paper singularly parallels the old Denis and Schiffermüller theory of the nonexistence of this sex. Riley replied at length, quoting his own earlier paper[17] and publishing his well-known figures of the extensile abdomen of the male and its appendages (Fig. 2), including the male organ "telescopically extensile to about twice the length of his body."

Riley's assumption that "With this exposition of the details, the act of fecundation is no longer a mystery," seems to have received almost general assent. Rathvon[18] had written Riley, "I have never discovered such an organ . . . It is true that the abdomen of the male is capable of great elongation, but by stretching it artificially to its utmost extension, I never,

[16] Stett. Ent. Zeit., xxxv, p. 234–236, 1874.
[17] Am. Ent., ii, p. 35–38, 1869.
[18] Am. Ent., ii, p. 81, 1870.

by measurement, could reach any way near the anal extremity of the female"; and Haseman[19] in the most satisfactory study of this insect, based on original observation, published since Riley's time, corrects Riley's account and illustration with reference to the position of the female at the time of mating, describes the lengthening of the male abdomen, at mating, "to fully three times its normal length," and makes no reference to Riley's illustration and text indicating that the mating is made possible by a greatly specialized condition of the male genitalia.

Some of the views we have quoted are so obviously erroneous, that they require no further refutation; others may be true of some species, though not true of the Psychids in general; and of our own most familiar species, *ephemeraeformis*, there seems to be testimony sufficiently diverse to make it advisable, in the breeding of some hundreds of this and allied species, to observe minutely the phenomena of its apparent matings and the behavior of the two sexes, and as far as practicable, for its evidential value, to preserve a photographic record of what really happens, both outside the larval case of the female, and in the concealment of the case and of the female pupa-skin.

Over a period of several years, the writer has had large numbers of these insects under observation; these have included hundreds of living larvae and pupae from Delaware, North Carolina, and Texas, with lesser numbers from other States. When affixed for pupation, the cases have been brought into a closely screened room and suspended in a natural position, usually spaced from two to three inches apart, the males (as far as readily determinable) usually on separate racks from the females. Captive males were not usually permitted to mate, for any number of matings with attracted wild males, out-of-doors, were always possible. The dates of emergence (for Delaware) ranged from August 31 to October 26, emergences later than October 10 being few; pupae and full-fed larvae brought from North Carolina gave average dates of emergence ten days later than those from Delaware.

The emergence of the male may take place at any hour of the day or night, but the greater number of emergences take place in the afternoon, several hours before dark. An imminent

[19] Univ. of Mo., Agr. Exp. Sta. Bull. 104, *The Evergreen Bagworm*, 1912.

emergence is sometimes indicated by the violent twitching of the larval case; usually, however, the male pupa, which has the power to move up and down in its case, by slow steady pressure pushes part way out at its narrow lower end; occasionally, having pushed part way out, it withdraws again, even for a few hours; usually, however, the emergence proceeds steadily and rapidly from its first external symptom—the rounded swelling-out of the narrow lower end of the case as the pupa pushes downward, until the dark head and thorax protrudes, and the moth crawls out from its split pupa-shell, its wings partly expanding as it emerges. Within two minutes of its emergence, the moth may be seen clinging, head upward, to its pupa-shell or to the lower portion of its larval case, its soft wings vertically pendant and fully expanded; within ten minutes, with a sudden flirt the wings are shifted to the 'sloping roof' position, and soon thereafter the insect takes flight, though in late season emergences on cold days, the male may remain on its pupa-shell in a semi-torpid condition for many hours. The male is structurally incapable of taking food, in captivity it usually lives but a single day, and under the most favorable conditions its life is probably limited to a very few days. The mating flight is usually at its height between three and six in the afternoon, few males being attracted to the females before 1 P. M., and the flight usually ceasing, except on warm still evenings, before dusk.

It should not be necessary to demonstrate that the males find their way to the females by the sense of smell. Most entomologists who have bred the larger Saturnidae have had experiences paralleling those recorded at length by Fabre. Though the many recorded examples of the long distances over which this attraction is operative are most surprising, the fact that the attraction is transferable by contact to inanimate objects, and that it may persist for a time after the complete removal of the female, is sufficient answer to the weird theories of insect telepathy or electric communication which perennially crop up in the Sunday supplements, and occasionally in more serious publications. All of these phenomena are observable in the Psychidae. Hardenberg[14] records of *Acanthopsyche junodi* that "cases have come under our observation where females have

been visited by males which could only have come from a couple of miles distant." Our own experience with *ephemeraeformis* indicates the strong probability that many of the attracted males had travelled a mile or more. The attraction is usually definite enough to enable the male to select the case of a receptive female from among any number of other cases in close proximity. In one of our jars of *Eurucyttarus edwardsi* (brought to Delaware from Texas) an emerging male assumed the mating attitude on the case of a female, selecting this case from among thirty others which proved to be all males; and this, forty-eight hours after the lone female had emerged and had been preserved in alcohol. Though rare, mistakes in selection have been observed. A wild male of *confederata*, for example, attracted to our breeding cages and admitted, chose for mating a larval case of this species containing a dead and dry larva, other cases near by containing live females; and of the scores of *ephemeraeformis* matings observed in 1925 and 1926, one male after persistent efforts assumed the mating attitude, his abdomen inserted to the wingbases, in a small empty case attached by a larva to a larger case, the larger case also being empty. These, however, represent only two errors among great numbers of successful selections.

In securing matings of *ephemeraeformis*, the cases of the females were festooned on racks on an open deck, raised about fifteen feet from the ground; males sometimes appeared within five minutes of the exposure of these cases (brought from a closed and screened room); they approached the rack from all directions, first appearing at about the same level in the air, or even dropping down from over the house-roof; flying in broad sweeping curves, they drew nearer and nearer to the source of attraction, often for a time losing the scent and disappearing completely; when within two or three feet of the festooned larval cases, the behavior of the males becomes convincing that sight as well as scent then begins to have part in directing their flight; but scent and sight rarely suffice for the immediate selection of the case of a receptive female, and the awkward blundering flight of the male does not usually permit him to pass from case to case in regular succession; so that often he pauses momentarily on four or five cases before identifying the exact source of his attraction.

A successful choice proceeds as follows: the male alights on the case, antennae, wings, his whole body a-quiver with excitement; at a point just below the middle of the case he scrambles about on its surface for a few seconds, often partially encircling it several times before deciding that its contents are satisfactory; this determined, he proceeds to the narrow lower end of the case, takes a position head upward, curves his abdomen with its bare awl-like chitinous armature into contact with the narrow extremity of the bag, and begins to probe vigorously to effect entrance. In this process, his first and second pairs of legs are extended, and take part in the strenuous muscular exertion involved; the third pair of legs, shorter and thicker, claw at the bottom of the case and assist in its opening. The introduction of the point of the abdomen may occupy only a few seconds, or the struggle may continue for many minutes, the moth shifting his position from time to time, and probing the silk in place after place, before locating the collapsed narrow orifice of the bag; however, long the struggle, the moth does not pause in his frantic efforts. The point of the abdomen having entered the opening of the sack, the muscular exertion continues until insertion is well advanced; in the progress of this, the whole abdomen is telescopically extended, the white intersegmental membrane becomes more and more obvious, and the hairy vestiture of the body eventually appears as so many narrow rings marking the median areas of each extended segment; before this condition has reached its maximum, the muscular efforts of the insect are greatly decreased, and it seems apparent that the full extension of the abdomen into the larval case is being completed by pneumatic pressure, for its visible basal portion is tensely inflated as well as extended longitudinally; and when (as sometimes happens) only partial entrance is attained, the whole abdomen may become puffed out, like a rubber balloon.

The complete insertion into the case of the female of the male abdomen, up to the wing-bases (Plate XXIX), is followed by a period of apparent quiescence; the first and second pairs of legs release their hold and are folded across the breast; the incessant quivering of antennae and wings ceases; the short strong third pair of legs are tightly appressed and buried in

the hairy vestiture of the ventral surface, their tarsi having entered the silken tube with the abdomen and their claws hooked fast to its inner surface. Hanging thus motionless, suspended head downward, for a longer or shorter period (usually from four to ten minutes) the insect is relatively indifferent to outward happenings. The case, with its enclosed female and pendant male, may be picked up bodily, its position changed completely, light thrown upon it (for photography), or it may be carefully lowered into a cyanide jar, without the male manifesting any uneasiness or desire to escape.

It is a common occurrence for two or even three males (Plate XXIX, lower row) to arrive almost simultaneously, or in close succession, on the case containing a freshly-split female pupa; under these circumstances they seem entirely unaware of one anothers presence; side by side they struggle to insert their abdomens; has one already succeeded in this when the others arrive, this causes no change in their procedure; and that three males, simultaneously or in close succession and before any have withdrawn, are able to force their abdomens into the narrow silken tube which is obviously a tight fit for one, is significant of the force they are able to exert in this operation. Rarely, a male having relinquished its mating position on the case of a female, another male is attracted to the same case, and an apparent second mating occurs; in the very few instances where this was observed, the second mating followed closely after the first, and in no instance more than half an hour after the departure of the first male.

Thus far, the phenomena of mating are exposed to view and readily observable; discrepancies in the published accounts usually refer to what transpires, hidden by the larval case and the pupal skin of the female. Obviously, this can scarcely be determined, except by quickly killing the mating pair and opening the follicle. Dropped into a freshly charged killing bottle, or deluged with chloroform or carbona from a pipette, the male dies almost without a quiver and without apparent change of position; then, if we carefully cut away the concealing larval case, we find the head of the female protruding from her split pupa-shell, the inflated body of the male extending past her head and entering the pupa through this split, which is held apart by the anterior segments of the female (Plate XXX, Fig. 1);

her body tightly fits the pupa-skin, and the abdomen of the male is flattened by pressure, as it passes upward between her body and the wall of the shell. Without relative change in the position of the two insects, we can remove the concealing pupa-shell piece by piece, uncovering the hidden portions of the two insects. (Plate XXX, Fig. 2). The flattened body of the male, usually occupying a position lateral to that of the female, passes upward toward, but not to, her anal extremity, often, indeed, not extending more than half the length of her body. Whether we kill the mating pair at the beginning or toward the end of the supposed mating period, the results are the same. Contradicting the possible assumption that the eggs are being fertilized as laid, we find that even up to the departure of the male no eggs have been extruded by the female. Neither do we see any trace of the extensile male organ, to which Guilding, Berg and Riley ascribe the office of bridging the gap from the abdomen of the male to the genitalia of the female. From the uniformity of results by this method of examination, it is evident that if a mating does take place, its interval must be very brief, or else the killing of the insects has not been sufficiently prompt to obviate some movement and change of position on the part of one or both. The larviform female, protected by her silken case and her chitinous pupa-shell,—even when extracted from these, resistant to the killing agents employed,—might conceivably survive long enough to change completely the relative position of the two insects. To exclude the latter possibility, some method of ensuring the instantaneous death of both insects, and if possible of hardening and rendering them rigid in the position of death, must be employed; and this was found in the simple device of plunging the insects, larval case and all, into boiling water. This resulted in very bedraggled unsightly specimens; but invariably also in securing the desired evidence. The larval case, the female pupa-shell carefully dissected away (Plate XXX, Fig. 3), uncover the male with his abdomen almost unbelievably extended, its apex bent over to meet the female, their genitalia not only in actual contact but so firmly welded together that they strongly resist separation; and in this mating contact there is no external appearance of the long male organ so often depicted as the agent by which

union of the sexes is possible. The existence of such an organ cannot be doubted; but its function, in part at least, has evidently been misunderstood.

If we dissect out the chitinized male genitalia (Plate XXXI, Fig. 1) of any of our larger Psychids, we find them comparatively simple in plan and exhibiting great similarity of structure among the various species. The strongly-chitinized narrow tegumen is produced into a pointed dorsal hood, shallowly cleft at its apex; this is the awl-like organ, by which access to the case of the female is attained; the harpes (Eyer) are small and mitten-shaped, a shortly-spined sacculus forming the thumb of the mitten; the saccus is long and narrow. Thus far, the genital structure of *ephemeraeformis* follows closely that of the larger narrow-winged Psychids throughout the world; but in the structure of the aedoeagus,—the penis-sheath,—our western hemisphere species of *Thyridopteryx* and *Oiketicus* depart widely even from those eastern hemisphere species which bear to them a close superficial resemblance, and which have usually been referred to the same genera. In the eastern species studied, this organ is tubular and of almost uniform diameter throughout; in our western hemisphere species, it has a slender laterally-curved swan-like neck, a spout-shaped termen (sometimes present in eastern species), and a greatly expanded bulbous base, all strongly chitinized and destitute of spined armature. Filling the neck of the aedoeagus, and in convoluted folds occupying most of its bulbous base (Plate XXXI, Fig. 2), is the soft slender *ductus ejaculatorius* (Pierce) figured by Guilding and by Riley as a long-extrusible retrorse-haired organ. The termen of this organ is expanded in the spout of the aedoeagus, *to which it is in structural union* by a thin elastic membrane. That is, the *ductus* is extrusible from its sheath to the limit of the elastic expansion of its membraneous vesica, and beyond this only by eversion. It is true that in material prepared in the usual way for the study of the chitinized genitalia, the *ductus* (Plate XXXI, Fig. 3) may be drawn out to its full length of 18 mm.; for the caustic potash weakens or dissolves the attaching membrane to such a degree that its presence easily eludes observation, and even in fresh material the membrane is so delicate that in this too the union of the aedoeagus and the enclosed *ductus* may be overlooked. Since the structure of

this organ, therefore, prohibits its extensive protrusion except by eversion, and since the examination of mated pairs indicates clearly that its office is not, as has been supposed, to bridge the gap, externally, from the extremity of the male abdomen to that of the female, it would be a natural inference that this thread-like organ, in mating, unwinds through the orifice in the base of the bulb, thus accommodating itself entirely within the body of the male to the enormously lengthened abdomen. In making mounts of the genitalia of *ephemeraeformis* by the usual method, this latter interpretation, too, fails of confirmation; for although the unwinding of the *ductus* from the bulb is so easily brought about that it is often difficult to dissect out the aedoeagus without this occurring, yet in most dissections of mating males the *ductus* is found with only its basal extremity (or rather, the point at which its diameter suddenly decreases, its tenuous continuation not being included in its stated length of 18 mm.) projecting from the bulb.

Finally, the true significance of the structure was first suggested by the occurrence, in the material studied, of a few males showing the *ductus* considerably protruded by eversion (Plate XXXI, Fig. 4), the organ thus becoming a double-walled tube from its point of attachment at the spout of the aedoeagus. By this eversion, the length of the *ductus* is to this extent halved. In one specimen, protrusion was noted to the extent of 6.75 mm., accounting for 13.5 mm. of the total length of the ductus; when we add to this the 4 mm., the length of the aedoeagus, in which the basal portion of the *ductus* remains, we have accounted for the whole length of the organ. To what extent, then, in mating, does the extruded double tube of the *ductus* enter the body of the female? Dissections were made of three mated pairs of *ephemeraeformis;* these show (Plate XXXI, Figs 5 and 6) the spout of the aedoeagus pushed out beyond the apex of the tegumen and entering the genital orifice of the female, where it is hooked fast; all three show the soft eversible double tube of the *ductus* projecting much further into the bursa, one of them shows this expanded vesica penetrating 6.75 mm. beyond the termen of the aedoeagus; this, as we have seen, accounts for the total length of the organ, 18 mm., to the point of its sudden contraction in diameter at the base of the bulb of the aedoeagus.

That is, in *ephemeraeformis* a normal lepidopterous mating takes place, the special phenomena relating only to the novel circumstances under which it occurs—the male outside, the female concealed within her larval case and pupa-skin. Studies of the internal structure of the female are very desirable; the eggs are to be observed, regularly arranged in curved strings which probably follow the convolutions of elongated ovarian tubes; but the whole internal structure is so tender and delicate that the material at hand, preserved in alcohol, did not suffice for its satisfactory study.

At the conclusion of the mating period, the abdomen of the male contracts to normal length as it is withdrawn from the case of the female; he rests for a few minutes upon the outside of the case, then flies away. In two instances it was noted that a male proceeded to an adjacent case and mated with another female, which is in accord with what has been recorded of European species.

The behavior of the females, fertilized and unfertilized, offers further evidence that *ephemeraeformis* does not ordinarily depend upon parthenogenetic reproduction for the continuance of the species. The following experiment, confirmed by often-repeated observations of great numbers of these insects, indicates the usual behavior of the female after mating: on the afternoon of September 10, fifteen females were mated with attracted wild males, in the open air; after the males had departed, the fifteen cases were suspended vertically, each over a shallow paper tray. At the expiration of two and one-half hours, two of the bags were opened, and oviposition was determined to be in progress; the eggs were being pushed forward in an almost continuous single string from the ovipositor of the female; mixed with down from her body, they already filled about one-third of the pupa-shell. At the expiration of four hours (from the mating), another bag was opened and similar conditions observed. The next morning (fifteen hours after mating) oviposition had been completed by the remaining twelve females, eleven of them had dropped from their bags to the paper trays; the twelfth female, still alive, had crept from her pupa-shell and occupied a position below it in her bag; a single egg had been extruded by one female, after dropping into the tray. Twenty-four hours after mating, all the females were alive in their

trays, but they had not extruded any more eggs. Forty-eight hours after mating, some of the shrunken females were dead, the others responded but feebly to touch. That is, experiment and observation indicate that egg-laying begins almost immediately after mating, and that at its completion the females usually leave their pupa-shells and bags, and drop to the ground to die.

It has been shown that the female, when mature, splits her pupa-shell, and still within this and her larval case, awaits the approach of the male. No male is attracted to the case of a female until her pupa-shell has split. A female, her pupa unsplit in the morning, attracts males in the afternoon, if in the interim she has burst her pupa-shell. Repeated experiments show that the unmated female continues to be attractive over a period of several days, males having been observed to come to her on the sixth day after her pupa-shell had split; the maximum period of attractiveness is probably materially longer than this.

Eventually, the unmated female, while still living, ceases to be attractive to males. When the period of waiting is too greatly prolonged, she deserts her pupa-shell without having deposited eggs, and pushes her way out (her head and thoracic segments) from the lower end of the bag. Her posture, thus suspended, has been designated by the English entomologists, "calling" the male, their interpretation being that the attractive scent of the female is thus more effectively diffused. This interpretation is probably correct for some species, including our own genus, *Oiketicus;* but it is not true of *ephemeraeformis*, for with it the assumption of this posture is an indication of approaching death; when assumed, the female is no longer attractive to visiting males, which uniformly pass her by in their search of adjacent cases for newly-matured and attractive females. These aged females, having reached the mouths of their bags, often die in this position; more frequently they fall to the ground while still living, where they twist about feebly, sometimes scatter a few eggs, and die; in no instance, by exploration of their bags, have we been able to detect any eggs laid by these infertile females in their pupa-shells. That is, the behavior of the fertilized and unfertilized females indicates

that a mating is antecedent to the orderly deposition of the eggs; that the unmated female either dies without ovipositing, or that if she scatters a few eggs at random, this occurs where they will be sure to perish.

The evidence, thus far, is all against the probability that parthenogenetic reproduction has any considerable part in the economy of *ephemeraeformis*. One other phase of this question is covered by the evidence at hand. In this family, wherever parthenogenesis has been demonstrated to be habitual, it has been found to occur either in species of which no males are known, or in places where males of the species are locally absent or numerically greatly in the minority. Do these conditions ever prevail, with *ephemeraeformis* or other North American Psychids?

Seiler[20] regrets that it is impracticable to determine the relative number of the sexes of newly-hatched Psychid larvae, for it is clearly conceivable that inherited variability in this respect may characterize different broods or strains of the same species, or that the mortality in the early stages of one sex may be much greater than of the other. Mrs. Treat[21] was convinced that under conditions of semi-starvation of the larvae (a common condition, due to over-population of the foodplant), males of *Lepidoptera* greatly predominate. Riley[22] expressed a contrary opinion of the cause, though his recorded experiments with *ephemeraeformis* are scarcely conclusive. It should be borne in mind, too, that under conditions of semi-starvation, dwarfed female larvae of *ephemeraeformis* construct cases closely simulating those of the males, and only by an examination of their contents after pupation is the proportion of the sexes surviving to this stage readily determinable.

Whatever the cause, other Psychids sometimes show an apparent numerical preponderance of males, rather than of females. Reference has already been made to *edwardsi*, that of thirty-odd cases collected in central Texas, all but one proved to contain males; similarly, the writer has bred between forty and fifty specimens of *celibata* from cases collected at widely separated localities and dates, has opened the larval cases of probably

[20] Arch. fur Zellforschung, xv, p. 251, 1920.
[21] Am. Nat. vii, p. 129, 1873.
[22] Am. Nat., vii, p. 513–518, 1873.

twice this number after emergence had occurred, yet he has never seen a female or a female pupa-shell of this species; all the cases had contained males. It is possible that this puzzling condition may be due to some habit peculiar to the females of these species, rendering their detection more difficult; but certainly the evidence at hand does not indicate for them a shortage of males.

Ephemeraeformis, a larger and more conspicuous species whose feeding habits permit ready observation throughout its larval life, and whose cases at pupation occupy the same sites, furnishes more satisfactory evidence. In 1925 and 1926 more than 600 cases were gathered in Delaware and North Carolina at the time of pupation; these represented many different infestations and foodplants; normal emergence was permitted and tabulated, and all of the cases were finally cut open, and the indicated fate of their occupants was made part of the tabulation; 307 males, 312 females, were found to have reached the pupal stage; the mortality in this stage, chiefly from parasitism, was much greater among the males, and the actual emergences of adults from the six hundred pupae were in the ratio of six females to four males. No included lots gave figures widely different from these general results.

This might seem to indicate the possibility, sometimes, of a shortage of males; yet when we remember that the females await the males over a period of days; that the male has been observed to mate with two females in succession; and that under field conditions two or even three males are not infrequently observed to be attracted to the case of a single female, the probability of such a shortage seems remote.

Thus by the numerical proportion of the sexes at the time of mating; by normal matings so frequently observed that we are justified in believing them to be the rule and not the exception; by the behavior of the females in awaiting their mates and in egg-laying, we have cumulative evidence against parthenogenesis in *ephemeraeformis* as of frequent occurrence. On the other hand, we have Riley's positive statement[23] that he has experimentally determined its exceptional occurrence in this species; we have the knowledge that in this family it sometimes

[23] Proc. Biol. Soc. Wash., II, p. 83, footnote, 1884.

becomes the rule rather than the exception; we have repeated observations indicating that in nearly related species, inheritance or external influences sometimes produce, locally, a great excess of males, or on the contrary sometimes even an entire absence of this sex. In this connection, Berg's note[24] should not be overlooked, to the effect that in the Banda Oriental (Argentine) he met with colonies of *Oiketicus geyeri*, where "among thousands, not a single male occurred, in other places on the contrary this sex constituted the entire majority."

The widely-distributed abundance of this insect; the ease with which its matings may be observed and controlled; its exceptional structural variability;[25] the probability that strains exist whose sex-ratios exhibit remarkable divergence; the possibility that these ratios may be modified experimentally, even to the elimination of one sex; all these point to *ephemeraeformis* as deserving more intensive study than has yet been accorded any North American Psychid. In the hope that this may be recognized as an opportunity, as well as a contribution to the biology of an interesting insect, these comparatively crude observations are recorded.

[24] Stett. Ent. Zeit,, xxxv. p. 236, 1874

[25] Jones, Ent. News, xxxiv. p. 97–99, 1923.

EXPLANATION OF PLATES

(All but plate XXXI fig. 3 represent *Thyridopteryx ephemeraeformis* Haw.)

Plates XXVI and XXVII

Bags of males and of females, from various foodplants.

Plate XXVIII

Virgin females extracted from their pupae. Sections through bags of females, showing pupa and contained eggs.

Plate XXIX

Males in mating posture on bags of females; the lower row illustrates the attraction of two or of three males to the same bag, their abdomens inserted simultaneously.

Plate XXX

Fig. 1.—Pairs in mating position, the larval cases removed; the inflated abdomens of the males enter the slit pupa-shells of the females.

Fig. 2.—The pupa-shell removed; the enormously extended abdomen of the male is shown occupying a position lateral to that of the female, but not reaching her anal extremity.

Fig. 3.—A true mating; the condition uncovered when the mating pair is instantaneously killed without opportunity for the insects to change their relative positions.

Plate XXXI

Fig. 1.—The male genitalia.

Fig. 2.—The aedoeagus, showing within its bulbous base the convoluted folds of the *ductus ejaculatorius.*

Fig. 3.—The *ductus* (of *Oiketicus abboti Grt.;* that of *ephemeraeformis* is almost indistinguishable) broken loose from its sheath, the aedoeagus.

Fig. 4.—The aedoeagus with the termen of the *ductus* (the "vesica") extruded and double by eversion.

Fig. 5.—Anal extremity of the female; the oviduct opens at its termen, and the genital aperture is at the caudal margin of the broad darkened plate.

Fig. 6.—Position of the parts in an actual mating (balsam mount preparation); the spout of the aedoeagus of the male is hooked within the genital aperture of the female, and the double tube of the vesica penetrates (in some mounts, 6 mm.) further.

Bags of *Thyridopteryx ephemeraeformis*, Males

FOODPLANTS

Wild Cherry
Arbor-vitae

Willow
Honey Locust

White Pine
Live Oak

JONES—MATING OF THE PSYCHIDAE

Bags of *Thyridopteryx ephemeraeformis*, Females

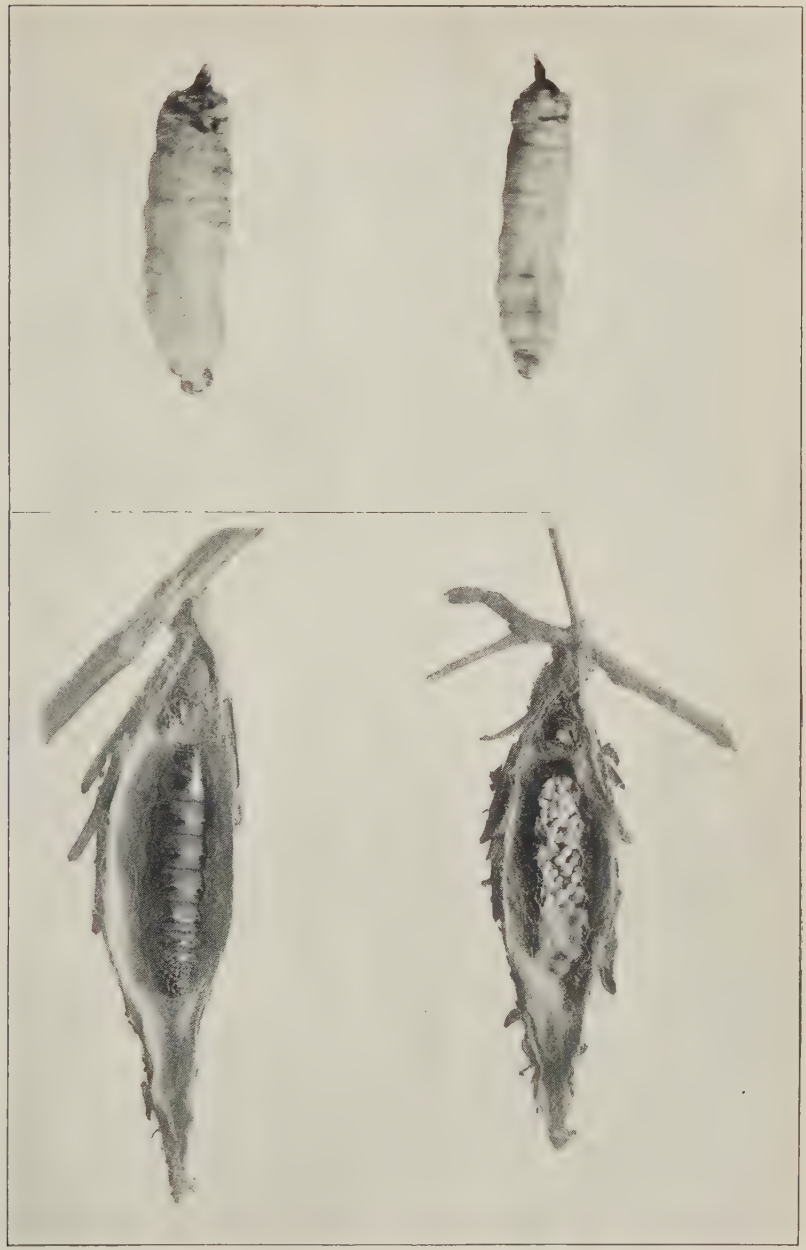
FOODPLANTS

Wild Cherry
Live Oak

Willow
Fir

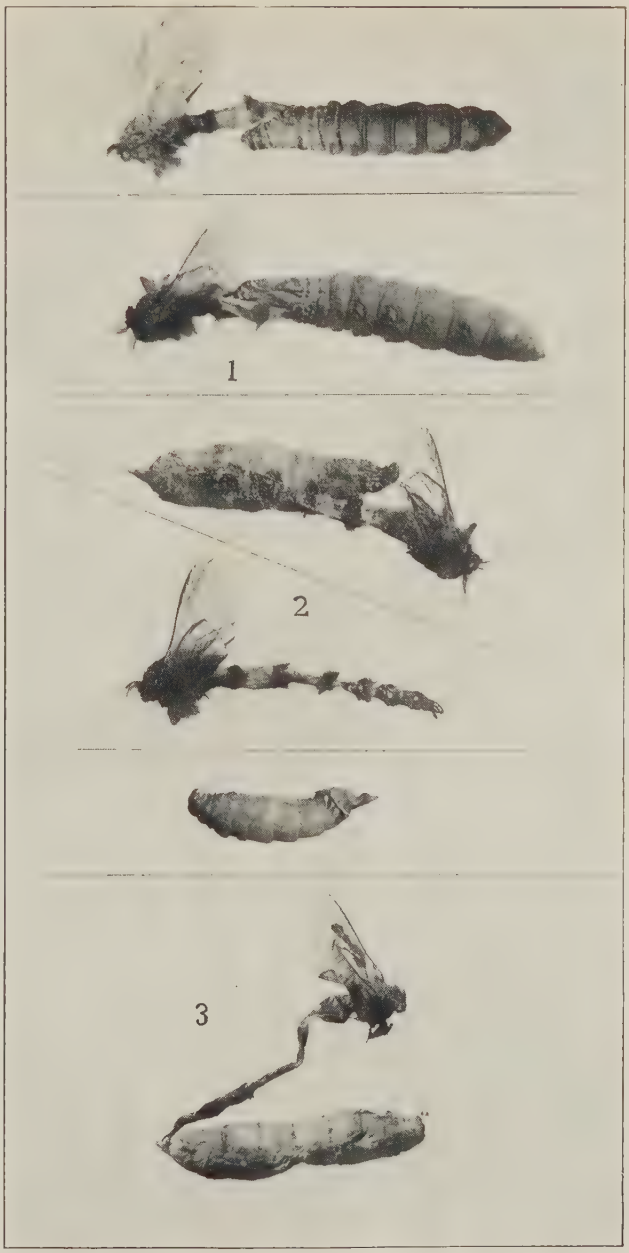
White Pine
Arbor-vitae

JONES—MATING OF THE PSYCHIDAE



JONES—MATING OF THE PSYCHIDAE

JONES—MATING OF THE PSYCHIDAE



JONES—MATING OF THE PSYCHIDAE

JONES—MATING OF THE PSYCHIDAE

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Yours &c
E. T. Cresson

EZRA TOWNSEND CRESSON

A CONTRIBUTION TO THE HISTORY OF ENTOMOLOGY IN NORTH AMERICA

BY

PHILIP P. CALVERT

WITH

ESTIMATES OF CRESSON'S WORK ON THE HYMENOPTERA

BY

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PHILADELPHIA

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EZRA TOWNSEND CRESSON

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BY PHILIP P. CALVERT

Zoological Laboratory, University of Pennsylvania, Philadelphia

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The Historical Background

At the middle of the nineteenth century, as the result of the labors of Cuvier, Lamarck, Latreille, the two Geoffroy St. Hilaires, de Blainville and their brilliant associates, Paris was the centre of research in zoology, including entomology. That remarkable series of taxonomic volumes, the "Suites à Buffon," had, in large part, appeared; the volumes on entomology included those on Orthoptera by Audinet-Serville (1839), Hemiptera by Amyot and Serville (1843), one volume on Lepidoptera by Boisduval (1836), Neuroptera by Rambur (1842), Hymenoptera by Lepelletier de St. Fargeau (1835–1845) and Brullé (1846), Diptera by Macquart (1834–1845) and Aptera by Walckenaer and Gervais (1837–1847); Lacordaire, although removed to Liège, had completed the "Introduction a l'Etude de l'Entomologie" (1834–1838) and had begun the series on the Coleoptera.

In Germany the brilliant coleopterist, W. F. Erichson, had just died (1849) at the age of forty, and the activities of E. F. Germar, who also had chiefly concerned himself with Coleoptera, were drawing to a close. Burmeister had published the five volumes he was to write of his "Handbuch der Entomologie" (1832–1855) before taking up his permanent residence in Argentina, as Director of the Public Museum in Buenos Aires. His first volume had been translated into English by W. E. Shuckard and published in London in 1836 as "A Manual of Entomology."

In Switzerland, Henri F. de Saussure was active in the study of the Hymenoptera and has given special attention to some American representatives of the order.

In England Kirby and Spence's "Introduction to Entomology" had been out for twenty-four years and had a newer rival in Westwood's "Introduction to the Modern Classification of Insects" (1839–1840). The Rev. William Kirby, Fellow of the Royal Society and President of the Entomological Society of London, had just died (1850) and Westwood, Keeper of the Hope Zoological Collections at Oxford since 1849, was to become in 1861 the first Hope Professor of Invertebrate Zoology in the University with his duties tacitly confined to the Insects.[1] Dr. John Edward Gray headed the Zoological staff of the British Museum and Francis Walker and Frederick Smith were active in the study of the Hymenoptera in the same institution.

[1] The small superscript numbers refer to the notes at the end of this memoir.

Louis Agassiz had come to the United States in 1846 and, after some hesitation, had become professor of zoology and geology in the Lawrence Scientific School of Harvard University, events destined to place the leadership in American natural history in Massachusetts for three decades. Thaddeus William Harris, librarian of Harvard, had gained wide recognition for economic entomology by his "Treatise on some of the Insects Injurious to Vegetation" (1842). Asa Fitch was soon (1854) to be named the first official economic entomologist (for the State of New York). Thomas Say, a native of Philadelphia, one of the founders of the Academy of Natural Sciences, professor of natural history for a few years in the University of Pennsylvania, and one of the first native systematists in the United States, had died at New Harmony, Indiana, in 1839, but his work was being continued by the Melsheimers and Haldeman in Pennsylvania and the LeContes, father and son, in New York City. An Entomological Society of Pennsylvania had been organized in 1842, with a resident membership of four: E. F. Melsheimer, S. S. Haldeman, D. Ziegler and J. G. Morris, which met several times a year at the respective homes of the members in the Susquehanna valley; how long it continued its historian does not state.[2] The Smithsonian Institution had been established in Washington in 1846 and under the direction of its secretary, Joseph Henry, was beginning its encouragement of the study of zoology and entomology of North America by such publications as Agassiz's "Classification of Insects" (1850), Leidy's "Fauna and Flora within Living Animals" (1853), Melsheimer's "Catalogue of Coleoptera" (1853) and Osten Sacken's "Catalogue of Diptera of North America" (1858).

In Philadelphia Joseph Leidy was beginning his career as a comparative anatomist and was not to exclude the insects from his studies. Haldeman was professor of natural history at the University of Pennsylvania from 1851 to 1855. John Lawrence Leconte in 1852 removed from New York to Philadelphia, there to continue his study of the Coleoptera to the end of his life in 1883. Thomas Bellerby Wilson, who had studied medicine in Paris and attended the lectures of Cuvier, had begun his munificent gifts which were increasing the collections and the library of the Academy of Natural Sciences.

Such were some of the most recent events which determined the state of zoology and especially of entomology, at the time (1859) when Ezra Townsend Cresson first made his appearance as a devotee of the latter subject. The doctrines of catastrophism and the fixity of species, and a thorough-going teleological explanation of nature, were still widely accepted.

Cresson's Descent and Earliest Years

The descent of Ezra Townsend Cresson is known for seven generations back to Pierre Cresson, who settled in the New World in the middle of the seventeenth century. The direct line from Pierre to Ezra Townsend is as follows.[3]

Pierre Cresson m. Rachel Claes or Cloos
(1610?–1686?) (? –1690)

Jacques Cresson m. Marie Reynard
(? –1684) (? –1710)

Solomon Cresson m. Anna Watson
(1674–1746) (? –1744)

James Cresson m. Sarah Emlen — Thomas and Sarah Townsend
(1709–1746) (1709–1752)

Caleb Cresson m. Annabella Elliott — John Townsend m. Grace Croasdale
(1742–1816) (1743–1793) (1724–1800)

John Elliott Cresson m. Mary Warder — Ezra Townsend m. Elizabeth Paul
(1773–1814) (1775–1863) (1760– ?)

Warder Cresson m. — Elizabeth Townsend
(1798–1860) (1799–1882)

Ezra Townsend Cresson

Pierre Cresson is believed to have been a native of Picardy. Being of the Reformed religion he took refuge in Holland, where he married and became a gardener to the Prince of Orange. In 1657 he emigrated with his family to New Amstel on the Delaware River. Within a year or two he removed to New Amsterdam on Manhattan Island and in 1680 to Staten Island, where probably he died.

Jacques Cresson was doubtless born in Holland, although no record of his birthplace and date has been found. Both he and his father were officers in the military companies formed for the protection of the settlements on Manhattan Island. After his death, his widow went to Curaçoa, but in 1696 she purchased land and a house at 4th and Chestnut Streets, Philadelphia. Her death is recorded in the records of the Society of Friends in that city, two of her sons being in membership with the Society.

Solomon Cresson, born in New York City, doubtless went with his mother and brother to Curaçoa. He was in Jamaica in 1696. Later he purchased a part of his mother's lot in Philadelphia and carried on the business of turner and chair-maker. From this time on that branch of the family, of whom Ezra Townsend Cresson formed a part, continued to live in Philadelphia.

James Cresson was connected with his father in business.

Caleb Cresson served an apprenticeship of four years and six months with Thomas Clifford in Philadelphia, but did not engage in mercantile pursuits on his own account, having inherited a large property. He took an active part in the affairs of the Society of Friends.[4] He was notable for his beautiful handwriting, a peculiarity which to a great degree characterized his great grandson. In 1793, when Philadelphia was visited by the yellow fever, he and his wife remained in the city. The latter was attacked by the epidemic while both were on a visit to their sons at Radnor, and died there of the fever.

John Elliot Cresson was a conveyancer.

Warder Cresson, father of Ezra Townsend Cresson, was a deeply religious man, successively a member of various sects, U. S. consul at Jerusalem, Palestine, in 1844 and finally a convert to Judaism.[5]

Elizabeth Townsend, mother of Ezra Townsend Cresson, was a daughter of Ezra Townsend, of Byberry, Bensalem Township, Philadelphia. Her great grandfather, Thomas Townsend and Sarah, his wife, came from Westbury, Long Island, and settled in Chester County, Pennsylvania, previous to 1734. After the death of Thomas, Sarah, with her children, removed to Byberry in 1754. Her son John purchased a property on the Poquessing Creek, in Byberry, on which he erected a flour mill. Here he spent his life; married Grace, daughter of Jeremiah Croasdale,

of Bucks County. He was remarkable for the regularity of his temper and conduct through the whole course of his life. His son Ezra married Elizabeth Paul, daughter of James and Susanna Paul, and settled on the old homestead. Few men stood higher in the estimation of the community than Ezra Townsend.

Ezra Townsend Cresson was born at Byberry, June 18, 1838. His father and mother were married December 12, 1821; their eldest child was born in 1822. Ezra was the seventh of eight children, four girls and four boys.[3] Of his early life we have no information. His family have very few records or memoranda earlier than 1859. His father living in Palestine from 1844 to 1848, and from 1852 until his death in 1860, was away from home and his family did not accompany him there. Ezra attended the public schools of Philadelphia as far as the "first" or highest division of the grammar school,[6] corresponding to the present (1927) eighth grade, but not a high school, and while he is supposed to have been compelled to work for the support of his mother, the occupation in which he engaged is not known. The earliest records we have of him are that he visited the Cave of the Winds at Niagara Falls, on August 28, 1855; and that he took part in a balloon ascension, under the charge of Mons. Godard, on July 16, 1857, starting from Lemon Hill, Philadelphia, and descending in Montgomery County, Pennsylvania, seven miles north of Norristown. Of this flight, Cresson contributed an account, dated July 17, 1857, to the *Pennsylvania Inquirer*.

Foundation of the Entomological Society of Philadelphia

Our next definite information concerning him is contained in a History of the American Entomological Society prepared by himself in 1909 "by request of the Society."

> On February 14, 1859, James Ridings, George Newman and Ezra Cresson met together at the residence of the latter No. 728 Erie [now South Warnock] Street,[7] Philadelphia, with the view of forming a society 'whose object shall be the advancement of entomological science by ascertaining the name, locality and habits of insects found within the United States of America.' After discussing the matter thoroughly, they decided to invite to the house on the evening of the 22d of the same month, such of their acquaintances as were interested in the study and who would likely become members. In accordance therewith invitations were sent to sixteen persons to attend.

EZRA T. CRESSON IN 1867
HOUSE, NO. 728 SOUTH WARNOCK ("ERIE")
STREET IN 1927

Of the three founders, James Ridings was born in England in 1803 and came to Philadelphia in 1830. He collected insects in Colorado and Kansas in 1864, in Georgia in 1865 and in the Shenandoah Valley, Virginia, on several occasions. He was the first vice-president, but for one year only (1859), and curator from 1875 to 1878. He lived until July 29, 1880, but never published.[8] His daughter, Mary Ann Ridings, became the wife of Ezra Townsend Cresson on March 2, 1859.

George Newman was the second president of the new society, holding the office two years, 1861 to 1862. When a proposition was made at the Society's meeting on July 14, 1862, to occupy quarters at 518 S. 13th Street, President Newman suggested that the question be postponed until the next stated meeting. This not being agreed to, Mr. Newman never appeared at the meetings again, resigned the Presidency on October 13 of the same year and his membership on March 13, 1865.

Ezra Townsend Cresson was the youngest of the three founders, at this time not yet twenty-one years of age. He was between five feet five inches and five feet six inches in height, slender, with light brown hair and blue eyes. The source from which we have drawn the account of his ancestors[2] contains no mention of any of them in the direct line as having had an interest in natural history. Members of collateral lines were eminent in philanthropy, fine arts, manufacturing, engineering and chemistry. His interest in entomology was kindled and encouraged by his future father-in-law, James Ridings, who was a great lover of nature and an energetic collector. Long before the Society was organized, young Cresson would often accompany Ridings in his long walks into the nearby country collecting butterflies and beetles, of which the latter had a fine collection.

The organization meetings of February 22 and March 1, 1859, resulted in the formation of the Entomological Society of Philadelphia. Among the original members, in addition to the three who issued the call, were Dr. Thomas Bellerby Wilson, president of the Academy of Natural Sciences of Philadelphia in 1863 to 1864, and an active collector of insects both by his own labors and by purchase; Charles Wilt, whose extensive collection of Lepidopters was subsequently added to that of the society; James H. B. Bland, active collector of Coleoptera, describer of several new species and president of the new society, 1863 to 1865;

James W. McAllister, who made the first written communication (on *Monocrepidius auritus*—Coleoptera) and who married Annabella Cresson, Ezra Townsend's youngest sister; Henry Feldman, who gave his name to the Feldman Collecting Social,[9] a social entomological club which flourished under the guiding spirit of a grandson, Henry W. Wenzel, from 1887 on for more than thirty years; and Dr. J. L. LeConte, the greatest authority in the United States on the Coleoptera. Within the first seven years of the Society's existence there were added to its membership roll the names of Charles A. Blake, monographer of the Mutillidae, Dr. George H. Horn, ranking second to LeConte, Edward D. Cope who studied certain Myriopods as a side line[10] when his attention was not absorbed by the Vertebrates; Joseph Leidy, with well-known monographs on *Spectrum*, *Belostoma*, *Corydalus* and the nematoid entozoa affecting insects, to testify to his entomological interests; and William Wenzel, first of three generations of that surname, whose achievements as collectors have been recognized far and wide.

This list gives some idea of the entomological environment which his new society furnished the youthful Cresson.

There still exists, in the archives of the Society, a small slip of paper in his handwriting, endorsed "Coleopterous Communications Num. 4, E. T. Cresson read March 28, 1859 Recorded Page 1", reading as follows:

On the 10th of March 1859 I took the '*Diaperis hydni* Fab.' in large quantities in an old rotten stump in a wood in West Phila.; they were in a torpid state when found. On the 16th of March, 1859, I took a large quantity of the '*Prometopia 6-maculata* Say' under the back of a dead Oak tree near Gray's Ferry, also any quantity of the '*Oplocephala bicornis* Oliv.' amongst fungi on a log. All in a torpid state when found. Dated Mc. 28. 1859.

This communication antedates the earliest printed Proceedings of the Society.

There is still in existence a letter from Thomas T. Firth, Treasurer of the Pennsylvania Railroad Company, to Professor Joseph Henry, Secretary of the Smithsonian Institution, dated April 6, 1859, introducing Cresson to Henry in the hope that a position might be found for him in the Institution. From this letter it is evident that Cresson was at that time a clerk in the Treasurer's office, but desired to make a change for the benefit of his health as well as to find something more congenial to his taste for the natural sciences. Apparently nothing came of this application.

Removal to Texas and Return to Philadelphia

At the meeting of the Society, May 8, 1859, Cresson's resignation as Secretary was read and accepted with regrets. He was absent, having gone with his young wife, his brothers, John Elliott and Jacob, their families and all their belongings to New Braunfels, Comal County, Texas. They pooled their resources in a ranch near the Comal River with the intention of raising cattle; a venture which, owing to the unpropitious season and their inexperience, and probably the tension, later resulting in the Civil War, not rendering a Northerner's life in that state altogether agreeable, resulted in the return in September, of the same year, of Ezra and Jacob, John remaining in hopes of continuing. The latter, however, followed a year or so later, nearly losing his life while passing through turbulent Kansas. Ezra did considerable collecting in that short time, securing for his own and the Society's collection many species new to them and to science.

The Entomological Society possesses the following letter from him.

New Braunfels, Comal Co.
Texas, July 5, 1859.

To the Members of the
"Entomological Society of Phila."
Gentlemen.

Yesterday morning I was much pleased to capture about 50 specimens of "*Megacephala carolina Linn.*" on the banks of the Comal River. I found them under stones near the edge of the water; to test this locality I spent much time in overturning stones as near as 3 yards from the shore, but I found none so far off of the water, they also confine themselves to stony locations which slope gently to the water, to which they intend to have easy access. They do not fly, but run like lightning & are rather difficult to secure. If the Society had a collection I could contribute a great many valuable & rare specimens to it, but as it has no such an institution* I will send a few specimens to a friend to be distributed among some of you who may not have them already. I will try to send as many communications as possible & trust that they will prove worthy of a record on your books.

Very respectfully,
E. T. Cresson.

I would be much pleased to receive a line or so from any of my fellow members.

E. T. C.

* At its meeting on November 28, 1859, the Society decided to form a general collection of insects. *Cresson's History*, p. 17.

He appeared again at the Society on Oct. 24, 1859. In January, 1860, when the Entomological Society established itself in Charles Wilt's residence, E. T. Cresson is recorded as contributing the window shades and, at the meeting of February 13, 1860, he "presented his entire collection of Coleoptera with the statement that it was his intention to present also such additional specimens as he should collect from time to time and also to exert himself as much as possible for the good of the Society."

Renewal of Work with the Society

In 1861 the Society inaugurated its "Proceedings." The report of the Recording Secretary for that year stated:

> . . . The publication was immediately commenced. The first and second numbers were printed on a small hand press, one page at a time, occupying much time and labor . . . The only expense attending the publication is the ink and paper; the composition and press work being done voluntarily by the members of the Committee, and another member does the binding.

From August, 1862, to January, 1876, the Society occupied a two-story building at 518 South 13th Street, at the northwest corner of 13th and Rodman Streets, consisting of a single room on each floor. In 1909, Cresson wrote:

> The amount of hard work done in those two rooms during more than thirteen years is known only to those who did the work. . . . Almost every night, members were working some on the library, some on the collections in the upper room, while on the lower floor, types were being set and the press in motion printing the pages of the 'Proceedings' and all giving their time and labor freely, cheerfully and willingly.[11]

On the death of Charles A. Blake, Mr. Cresson wrote:

> I remember the many nights Mr. Blake toiled with me in the publication of the Proceedings and Transactions, and he was ever ready and willing to help me when no others volunteered; we worked together side by side at the case, and while I rolled on the ink, he pulled the press—being the stronger.[12]

At the Society's meeting on March 14, 1859, Baron Karl von Osten Sacken, secretary of the Russian Legation at Washington and an active entomologist, was present. In his reminiscences published in 1903 he gives this interesting glimpse of Cresson and the Society:

> Residing, as I did, in Washington (up to 1862), I had the opportunity of witnessing the origin and first beginnings of the Society. To me, a European, these beginnings afforded such a remarkable insight into American energy and enterprise that I am glad to give a short account of them. . . . The

most active member of the Society, however, was its Corresponding Secretary, Mr. Ezra T. Cresson, with whom I kept up at that time an active correspondence. I shall content myself with reproducing passages of his letters, which speak for themselves.

On September 4, 1861, Mr. Cresson wrote: "We do our own printing as you already know; I am the compositor and also assist in the press work, and although I have had little or no experience in setting type (I have set the type for *all* the pages of the *Proceedings* thus far), yet be assured that I will do my best to have your paper got up in as neat and scientific a style as possible."[13]

Earliest Entomological Publications

It was appropiate that the first volume of the new "Proceedings" should contain Cresson's first extensive paper—"Catalogue of the Cicindelidae of North America." It was also his last on that Order of Insects. He may have realized that the Coleoptera had received and were receiving much attention from his predecessors and associates and that the general progress of entomology would be aided to a greater degree if he devoted himself to some other group. This hypothesis receives some support in the opening paragraph of his second paper in the "Proceedings," a "Catalogue of the described Species of Tenthredinidae and Uroceridae inhabiting North America."

The compilation of a catalogue of the described species of North American Hymenoptera, on the same plan as Melsheimer's Coleoptera, Osten Sacken's Diptera, and Morris's Lepidoptera is very much wanted, and would be of great assistance to the student as a basis to work upon.

The descriptions of our Hymenoptera are scattered through the Transactions of learned societies, Scientific Journals, Pamphlets and other publications difficult of access and presenting a serious obstacle to any one endeavouring to identify specimens.

Therefore, as it is not certain when the expected work of M. Saussure on the Hymenoptera of North America, will appear, I propose to publish in the Proceedings of The Entomological Society, a series of Catalogues of our species commencing with the Sawflies and to continue on with a list of the other families as my time will permit or until Saussure's work appears. This plan will enable the student to commence operations forthwith and may also be the means of encouraging others to study and collect.[14]

Glimpses of Cresson as a collector in the vicinity of Philadelphia are afforded us by the early volumes of the "Proceedings." He was above Frankford, Penna., on May 4, 1861, where he took *Sphyracephala brevicornis* Say, our only representative of the curious Dipterous family Diopsidae;[15] near Gloucester and Red Bank, New Jersey, in July, 1861,[16] and at Gloucester in September and October, 1863, for *Bombus*.[17]

Dr. Thomas B. Wilson and the Society

The great patron of the Entomological Society and of the Academy of Natural Sciences of Philadelphia, in these days, was Dr. Thomas Bellerby Wilson, already referred to, and Cresson was employed by him as a secretary practically up to the time of Dr. Wilson's decease. Wilson frequently bought collections of insects for the Society and these furnished the bases for a number of Cresson's papers—such as the "Hymenoptera collected by Mr. James Ridings during the summer of 1864, in the mountainous regions of Colorado Territory," "the fine original collection of Prof. Felipe Poey of Havana, Cuba."[18]

On March 15, 1865, Dr. Wilson died,[19] an event which materially affected the life of Ezra Townsend Cresson and to which he referred for many years as blasting, to great degree, the hopes entertained for the future of the Society.[20] On March 22d 1865, he wrote to J. A. Lintner, later State Entomologist of New York:[21]

> "We are all upside down now, in consequence of the sudden death of our late much valued member Dr. Thos. B. Wilson. He was one of the main stays of the Society, & to him we owe almost our very existence. His death is indeed a heavy blow, not only to Entomological Science, but to Science in general."

The Civil War raged during Cresson's early manhood, from his twenty-third to his twenty-seventh year, but there is no record of his participating in it in any way. During these years his active entomological work in connection with the Society continued, apparently without interruption. When the draft came, he was prevented from entering the army by his employer, Dr. Wilson, who paid for a substitute, and whose "sympathies during the war were distinctly Southern."[22]

The Practical Entomologist

One other early effort of the Society, which also absorbed much of Cresson's energy is described in his "History" (p. 24) as follows:

> In August, 1865, the Publication Committee secured permission of the Society to publish short papers on popular entomology, under the title of 'The Practical Entomologist,' the first journal devoted to Economic Entomology published in the United States, for distribution among farmers and agriculturists, the cost of publishing the same to be defrayed by private contributions. The object of this publication was to procure and diffuse information, in a popular form, on Insects which were destructive or beneficial to vegetation in the United States. At first it was distributed gratuitously, asking from those disposed to give it, sufficient to pay the postage. It was expected that the receipts from advertisements would make the paper self-supporting; but on these liberal terms the demand for copies became so great that it was found necessary to ask the payment of the small subscription price of 50 cents a year to meet expenses, the income of the Society being at that time too limited to render any assistance. The publication was, however, continued for two years (October, 1865-1867) in about 260 quarto pages, containing a vast amount of valuable information on economic entomology. But the time had not yet come for the agricultural public to realize the importance and value of such knowledge, and the interest in the publication gradually fell off, so that at the end of the second volume it was found that the undertaking would not receive sufficient support, and it had to be abandoned. It was here that we felt the need of such a friend and helper as was Dr. Thomas B. Wilson.

The original Publication Committee and Editors of "The Practical Entomologist" consisted of Cresson, Aug. R. Grote and J. W. McAllister. Benj. D. Walsh took over the editorship at the beginning of Volume II, October, 1866, but Cresson continued to take charge of the business communications.[23] His letters to Lintner on the subject of this venture are of interest:

Sept. 19, 1865.

Mr. J. A. Lintner,
Dear Sir:—

I enclose you a circular, which I trust will merit your attention & cooperation, by sending us short papers containing information that would interest the Agriculturist. Any of your neighbors wishing a copy of the "Practical Entomologist," will receive it by sending their name and address . . . I have written Dr. Fitch to assist us in this new undertaking. As you are well acquainted with him, please try to induce him to contribute, as his papers would make the publication very valuable & interesting.

May 26, 1866.

My dear sir:—

Your kind letter of the 15th inst, enclosing a lengthy and very well written communication which you have published in your local paper,—came duly to hand.

Accept many thanks for the deep interest you take in the welfare of our little paper & be assured that you have assisted us very much in its publication. We find however that people are very slow in making up their minds to send 50cts. a year for the paper, although they are ready enough to send 12 cts to prepay the postage. In our 9th number due June 24th we shall make an announcement that if we do not receive at least 4000 or 5000 subscribers for the 2nd year, the publication of the paper will be discontinued. The Committee of Publications have already paid several hundreds of dollars out of their own pockets to keep up the paper so far, & they will see it through the first year, but will not attempt another year unless assured it will be selfsustaining. We shall therefore give 3 mos. notice, requesting those who wish to subscribe, at 50 cts a year, to send in their names, & as many of their neighbors as they can, & not to send the money until the receipt of the 1st number, when they will know that the number will be continued. We have a petition before Congress to aid us in the gratuitous distribution of the paper, but as the bill or petition has no reference to the "nigger" in it, it will hardly receive any consideration. If by chance they should assist us, we shall resume the original gratuitous plan; all we ask is that the receipts, from whatever source they may come, be sufficient to defray expenses. So far, we have received no new subscriptions from Utica, but a day or two since a lady in Ithaca, under the name of Mack, sent 50cts for a copy. The Hon. Ezra Cornell, might assist us if influence was used, but we have none. Does he live at Ithaca? I send him a copy regularly.

Cresson as Curator of the Society

In 1866 Cresson accepted the curatorship of the Society, a position whose precarious nature is evidenced in a printed appeal dated Philadelphia, December 28, 1868, and preserved in the archives of the Society. This appeal, signed by John L. LeConte, George H. Horn, Samuel Lewis, C. T. Robinson and Charles H. Hart states that they

. . . were appointed a Committee at a late meeting of the American Entomological Society* 'to devise a plan for the collection of a sufficient amount ($1250) to pay the salary of the Curator for the year 1869.' In performing this duty they deem it proper to state that the Curator's time is in great part occupied in conducting the business of the publications of the Society. He is not only Editor of the *Transactions* but is also Custodian of the property of the Society, and, when necessary, performs part of the press work and composition of the publications. It is his duty also to distribute these, and conduct a very large correspondence, chiefly in connection with the publications. It will be seen, therefore, that $1250 is but a small compensation for so much labor. . . In view of this condition of things, we appeal to you most earnestly for assistance; the liberal response made on former occasions by members of the Society, and others interested in the progress of Entomology, is, we think, a sufficient guarantee that we shall not ask in vain. It may be added here, that our very existence as a distinct body depends mainly on our ability to support a Curator; for should we ever fail to do this, the Society must either close its door, or join some stronger association.

This appeal was only partially successful, as is evidenced by the following letter from Cresson:

To the *Philada. April 12. 1869.*
Officers & Members of the
American Entomological Society
Gentlemen:—

At the close of last year, as usual, a Committee was appointed by the Society to devise a plan for the collection of a sufficient amount ($1250) to pay the salary of the Curator for the year 1869. An Appeal, a copy of which is annexed, was adopted by the Committee, & sent to the Members & friends of the Society. Up to this date, only $752.50 have been subscribed—not two-thirds of the required amount—and about one-half paid in, so far.

Heretofore we have not had any difficulty in raising the required amount, but the failure this year has been occasioned by receiving nothing from several who subscribed liberally last year & for several years before. Therefore the chances of raising the required amount this year & for subsequent years seem to be growing smaller & smaller. Being dependent entirely upon the salary I receive from the Society for support, this uncertainty for the present & for the future has caused me much anxiety, & has obliged me to look around for a situation which would produce me a regular income & upon which I could rely with some certainty.

* The name of The Entomological Society of Philadelphia was changed to The American Entomological Society in 1867 and the "Proceedings" of the former were continued by the "Transactions" of the latter.

Having been so long devoting the whole of my time to Entomological work, I felt very reluctant even to think of giving it up & returning to my old occupation of clerkship; but as duty comes before pleasure, I felt obliged to accept a position that was offered me lately, in an insurance office in this city, & at a salary not equal to one-half of what I have been receiving as Curator of this Society. In accepting my new situation I anticipated that the Society would allow me to retain the position of Curator at a reduced salary, provided that I would undertake to fulfill the duties of the office as far as lies in my power, until *one* of the two situations would produce me sufficient income to enable me to give up the other. There is no doubt that the Society can raise at least $600 every year, if any effort is made to do so, & I am of the opinion that if an *honest* effort was made by those who desire the American Entomological Society to be a permanent & prosperous institution, a fund could be raised in a few months that would produce an income sufficient to support a Curator & do much to increase its publications. I trust that such an effort will soon be made, & that the Society may be freed from the necessity of begging every year the money to support it during the year. Other Societies have made the attempt & been successful, & there is no reason why the only Entomological Society in the United States should not [be] successful also.

At the present time there is a balance of $175.93 in bank to the credit of the Curator's Fund, and about $300 are still due from subscribers, making a total of $475.93, which would be sufficient to pay a salary of $50. per month to the Curator.

While the Publication Committee is deprived of the income they should receive from the $6000 in Huntingdon & Broad Top R. R. Bonds, it will be impossible for it to give anything to the Curator's Fund, unless the publication is limited in number of pages to be printed, which would be impracticable to do, I should think. Therefore the Society will have to rely for the present upon what can be raised by subscription, to pay a salary to the Curator. I am aware that if I am allowed by the Society to retain the position of Curator, I will be obliged to work almost every night in order to attend to the correspondence & publications & keep them from going behind hand, but I shall promise to do my best to promote the interests & welfare of the Society. I therefore ask that you will consider this subject this evening, & take such action as may seem most proper for the good of the Society.

Very respectfully

E. T. Cresson

The insurance company to which the preceding letter refers was the Franklin Fire Insurance Company of Philadelphia, with which Cresson's brother-in-law, James W. McAllister, was associated.

He accepted the position as a clerk, April 30, 1869, and advanced successively to General Superintendent of the Agency Department in 1874. His thorough executive management of this Department and the compilation of an elaborate synopsis of the home business of the Company since its incorporation, so pleased the Board of Directors of the Company, that on April

8th, 1875, they presented him with a gold watch, chain and seal, and the sum of one thousand Dollars.

McAllister later became President of the company and Cresson, in October 1878, its Secretary. This position he resigned on February 16, 1910, on account of ill health, but he maintained a connection with the company which took him to its offices at least once a week until within a year of his death.

He retained the curatorship of the Society and the post of corresponding secretary until December, 1870,[24] as is evidenced by the following engrossed document found among his papers after his death.

> THANKS of the AMERICAN ENTOMOLOGICAL SOCIETY to EZRA T. CRESSON, Esq. At a Meeting of the American Entomological Society, held Monday evening December 12th, A. D. 1870: On motion of Mr. Robert Frazer a Committee was appointed, consisting of Messrs. William Ridings, Dr. Samuel Lewis, and Robert Frazer, who reported the following Preamble and Resolutions, which were unanimously adopted.
>
> Whereas Ezra T. Cresson, having declined a re-election as Corresponding Secretary and Curator of the American Entomological Society, which Offices he has ably filled since the organization of the Society:
>
> And Whereas, The American Entomological Society is under great obligations to Ezra T. Cresson, for the many valuable services rendered the Society since its organization, which have contributed greatly to its success in the various branches of Entomological Science, and feel that some acknowledgement should be made of the same Therefore
>
> Resolved, That the thanks of the society be respectfully tendered to Ezra T. Cresson, for the earnest and efficient manner which he has at all times performed his duties as Corresponding Secretary and Curator, and that it is with feelings of sincere regret, that the Official relations heretofore existing between him and the Society, are to so great an extent, about to be severed.
>
> Resolved, That a Copy of the foregoing Preamble and Resolutions, be suitably engrossed and signed by the Officers, and framed and presented to Ezra T. Cresson, Esq.
>
> J. FRANK KNIGHT, *Recording Secretary* — JOHN L. LECONTE, *President*
> CHARLES A. BLAKE, *Corresponding Secretary* — GEORGE H. HORN, M. D., *Vice President*

Cresson continued to edit the "*Transactions*" until 1913. He was elected Treasurer in 1874 and held this position for fifty years. He steadfastly declined nomination as president, to which office his fellow members would gladly have elected him.

After his return from Texas (1859) he lived in Frankford, Philadelphia, until about 1863, then removed to 738 South 12th Street, not far from his pre-Texan home. Here he did much of his entomological work. A member of the Protestant Episcopal Church, he took an active part in the Sunday School of All Saints' Church at Twelfth and Fitzwater Streets, where he taught a class of boys. His accomplishments as a printer enabled him to print many cards and other tokens used in the church's work. About 1881 he moved to Ardmore and in the Spring of 1883 to Swarthmore, both in Pennsylvania and each at about ten miles from Philadelphia.

Publications on the Hymenoptera, 1861–1882.

Along with these various activities and uncertainties attending his connection with the Society and with the insurance company, the preparation and publication of papers on the Hymenoptera steadily continued, numbering sixty-six in the years 1861-1882 inclusive.[25] This is an average of more than three papers a year, but they are, of course, of varying lengths; the years 1862 and 1866 are not represented; in 1870, 1871, 1874, 1876, 1877 and 1882 only one paper appeared each year; in 1879 nine, but none of them longer than eighteen pages. Not a few of them are descriptive of species belonging to more than one family, some are monographic or synoptic, as those on the North American species of *Nomada* (1863), of *Osmia* (1864), Philanthidae (1865), Pompilidae (1867), *Leucopsis*, *Smicra* and *Chalcis* (1872), *Sapyga* (1880) and *Eucerceris* (1882); some are catalogues, with or without the accompaniment of descriptions of new forms, as those on the North American species of Cynipidae, Chalcididae, Chrysidae, Crabronidae, Larridae, Bembecidae, Sphegidae, Scoliadae, Mutillidae, Formicidae, Eucmenidae [*sic*], Vespidae, Andrenidae and Apidae (1861),

Bombus and *Apathus* (1863), Ichneumonidae (1867, 1877), *Anthophora* (1864) *Aleiodes* (1869), Apidae (1879) and a new edition of his catalogue of Tenthredinidae and Uroceridae of North America (1880). There are also faunal papers, as those on the Hymenoptera of Cuba (1865, 1869), Colorado Territory (1865), Texas (1872) Mexico (1868, 1869, 1872, 1873, 1878), the western territories as gathered by the Wheeler Exploring Expedition (1875), of Utah (1876) collected by J. D. Putnam, the Pacific Slope of the United States and British North America (1878).

In the introductory paragraphs of his first and longer article on the Hymenoptera of Cuba he wrote:

> The materials used in the preparation of this paper are derived principally from the fine original collection of Professor Felipe Poey of Havana, Cuba, procured and most generously presented by Dr. Thos. B. Wilson to the Entomological Society of Philadelphia: also from the uniques in the collection of Dr. John Gundlach of Cuba, who has kindly loaned them to me, and who possesses, probably, the most complete collections extant of all orders of Cuban insects. To Professor Poey and Dr. Gundlach, I am greatly indebted for valuable notes upon the habits, etcetera of many species. [This article deals with the families Tenthredinidae to Apidae—but] Most of the Chalcididae, the Proctotrupidae and the Formicidae have been reserved for future papers. . . . Of the other families including the larger Chalcididae over 300 species are enumerated below, of which number about 250 seem to be new.[26]

His "Hymenoptera Texana" (1872), of 140 pages, was founded largely upon the "the splendid collection made in Bosque County" by G. W. Belfrage, "the fine collection in the Museum of Comparative Zoology at Cambridge, Massachusetts, made by Mr. J. Boll in Dallas County" and "a small collection of Mr. L. Heiligbrodt, made in Travis and Bastrop Counties." "Of the 19 families studied in this paper over 600 species are enumerated, nearly 300 of which appear to be new and are herein described."[27] Doubtless Cresson's own sojourn in Texas, brief though it was, gave him a special interest in the fauna of that State.

The following letters, whose originals are preserved in the United States National Museum, give some side lights on this work of Cresson's.[28]

AMERICAN ENTOMOLOGICAL SOCIETY

No. 518 South 13th Street

Philadelphia, Mch. 26 1867.

G. W. Belfrage Esq.

Dear sir:—

Your favor of the 9th inst. reach'd me a day or two ago. I have marked, on the enclosed slip, directions about the height to pin specimens. You had best pin all the specimens you can, & should any be too small to pin, they can be put on paper; but we would rather have them pinned if possible. Please collect *all the species* you can of *Hymenoptera* & *Diptera*. There is no special family we desire more than another. Wishing you every possible success, I beg to remain.

Jan. 11, 1872.

My Dear sir:—

This day I have sent you (c/o Forsgard & Co.) a box, by Express, charges prepaid, containing a part of your Hymenoptera Texana; also parts 8 & 9 of the "Butterflies of N. America" & No. 2 of Vol. 3 of Transactions. No. 3, concluding the volume is nearly ready. For over three months I have been kept so very busy at my business, that I have not been able to work scarcely any at insects, consequently I am able only to return a part of your insects at this time & will do my best to have the others ready soon. You will see by the list, included in the box, what I have yet to send you. Also, in consequence of want of leisure, I could send you only a few species in return for what you sent me or rather the Society; but will try to do much *better* next time. The labor of determining & describing species is great, & when I think that I must do all in the evenings, having to work all through the day-time, I am sometimes almost persuaded to give up Entomology after I finish my memoir on your Hymenoptera Texana. Should you have any more undetermined species, please send them as soon as possible, so that I may include them all in my paper & make one job of it. If I could work at insects in the day-time I could accomplish a great deal in a month.—With gas-light one works under difficulties, as some colors appear to change more or less, & besides this it is very hard on the eyes. The species I have retained are the most difficult to determine & will cost me much time & labor to get through them correctly. Several new genera will have to be established & most of them described as new species. I have never studied the Chalcididae & Formicidae & have returned them as "not studied"—Should I ever reach them in my studies I will let you know. I wish you would investigate the habits of the genus *Masaris* of which I send you 3 species, & of which you have found 2 new species.

Please collect all the specimens you can and let me know how much you will sell me a dozen pairs of each species. I shall be anxious to see what new kinds you may have for me to investigate & trust you will not delay in sending them on so that I may incorporate them with the others. I have packed the boxes (5 in all) as carefully as possible & all were in good condition when they left here, & I trust they will reach you in like condition. I would write you a longer letter, adding some notes on the species you have given me the opportunity to investigate, but want of time will, at present, deprive me of this pleasure. I will try to take the time, before long, & give you some notes. I will also write you about the books I send. You need not remit any money for Parts 8 & 9 until I write you to do so. If you could send me some specimens of *Massaris*, also of Nos. 436, 442, 457, 463, 464, 496, 533, 590 & 535 (♂ ♀). I would not ask any money in payment. Please let me know when you receive the box & in what condition as I shall feel anxious that you receive them safely.

Aug. 25th 1873.

DEAR SIR:—

Your favor of July 26th came to hand a few days ago, & made me feel glad to hear that you were alive and well, & still at work at insects. I shall be quite anxious to see your work on the insects of Bosque Co. Where do you propose to publish it? I do not feel altogether satisfied with Mr. Blake's determination of the species of Mutilla & Agama—thinking he has made too many species; hence, I would like very much to receive from you *for examination* as large a collection as possible of these genera, which you may send me when you have others ready which you desire me to determine for you. I would like to work up the new material you may have collected & publish an additional paper on Texan Hymenoptera. To do this I should receive them as soon as possible this fall or winter as one feels more like doing such work when the weather is cold. Send all packages to me at No. 738 So. 12th St. In a few days I will send you several copies of my paper on Hymenoptera Texana to which you are welcome. Mr. Heiligbrodt's address is P. O. Box 43, Bastrop, Texas. I do not know in what business he is engaged. Dr. LeConte has returned from Europe; Dr. Horn will probably not leave before spring of 1874. I shall put by for you a series of Californian Hymenoptera & send them along with the next box I send.

Corrections in "Hymenoptera Texana":—
(1) *Notocyphus dorsalis* Cres. is a variety of *N. plagiatus* Sm. (2) *Pepsis formosa* (Say) is *P. caerulea* Fabr. (3) *Panurgus picipes* Cres. belongs to the genus *Calliopsis* Sm. (4) *Panurgus ornatipes* Cres. is *Calliopsis andreniformis* Sm. (5) *Apathis variabilis* Cres. proves to be a variety of *A. insularis* Smith.

Mr. Smith writes me that you have sent me many new & beautiful species since the publication of my "Hymenoptera Texana"—I have not received any from you & suppose he must have misunderstood you—I shall be glad to see them.

November 24th 1875

My dear sir:—

I have your favor of 15th inst. & am glad to hear that you have received the box I sent you some time ago. I wish I or the Society were able to purchase your entomological collections they must be very fine, but we do not have the money. In your collections of Hymenoptera you have a number of types described by me from single specimens. Now, in case you disposed of your collections it would be a pity that these types should go out of the country. Could you not make up your mind to present them (the types) to this Society, so that they may be well preserved & at all times accessible to the student? Or if you could not do that, would you sell them to me at a reasonable figure, say 15 cts. each ? I hope however you will feel willing to make them a gift to the Society, as I myself am too poor just now to afford to spend the money, having a family to support & the times are hard this winter. I enclose here a list of species (types)[29] which are in your collection, but are not in that of the Society. Perhaps by this time you may have duplicates of some, in which case if you can send the original specimen from which the description was made, it would be more valuable to the Society. We are receiving offers, some very reasonable ones too, every little while, of very fine collections, but we are too poor to buy, having merely sufficient funds to pay the running expenses of the Society such as rent, light & fuel. We are about to move our collections & library into fire proof apartments provided for the Society in the new building of the Academy of Nat. Sciences in this city.* There our collections will be carefully preserved after you & I are in our graves. Dr. LeConte has not yet paid over the $9.20 you speak of; perhaps he is waiting instructions to do so from you. Please reply to this favorably if you can as soon as convenient.

* Under an agreement between the Society and the Academy whereby the former, although preserving its corporate existence, became also the Entomological Section of the latter. In 1924 the Sections of the Academy were abolished, but the Society continued its close union with the Academy.

Febry. 14th 1880

Dear Sir:—

I write to ask if you will endeavor to pick out and send me for the collection of the American Entomological Society, *as soon as you possibly can*, the types of new species of Hymenoptera which were unique in your collection at the time I published my Hymenoptera Texana. They are desiderata in our collection & it is very important that they should be preserved. In case of your death—which I trust is far distant—they might become scattered and lost to science. In a late letter you said you intended to present those types to our collection, & I hope you will be able to carry out your intention very soon. The collections of the Society are very large & valuable & will be carefully guarded from destruction, so that whatever you may please to place there, will be safe and accessible to science, for many generations to come. Please do not delay any longer than you can help in sending on the types desired.

I trust this may find you in the enjoyment of health & prosperity, & that you may live long to continue the work of bringing to light the Entomological fauna of Texas, so beautiful & interesting.

Please let me hear from you soon.

[Note 29 appended to this memoir shows the ultimate disposition of the Belfrage Collection.]

Another series of Cresson's papers deal with Hymenoptera "collected at the Hacienda del Potrero near Cordoba, Mexico, and presented to the American Entomological Society by Prof. F. Sumichrast of Orizaba."[30]

His vacation in the summer of 1878 was spent in the White Mountains, New Hampshire. There he collected some, and often remarked about the great number of Ichneumonidae he saw and captured on the windows of the Mt. Washington railroad train.

Some glimpses of Cresson's entomological life in these years is afforded by letters which he wrote to Lintner.

Mr. J. A. Lintner, *Oct. 11th 1880*

My dear sir:—

Your favor of 28th ult. received. It will be several months before I shall be able to attempt the determination of your Ichneumonidae, as I am now entering the busy season at this office, in which I shall be obliged to lay aside all other studies, except that of the best of all books—the Bible. As soon as I can see my way clear to name your specimens without keeping them too long, I will be most happy to undertake the task.

December 13th 1881

FRIEND LINTNER.

Your favor of Nov. & Dec. 9th both received. I have been too unwell to go to the Academy to look over Emmon's Agriculture vol. 5, until yesterday, when I had to go there to attend the annual meeting of our Ent. Soc. I send you the determinations requested, the best I can do. The figures are all poor, some better than others however, but none correct.

The parasite in *Crambus* (the specimen is returned to you today) is *Lampronota frigida* Cress. ♀, Can. Ent. vol. i, p. 36.

Mch. 15/83.

DEAR SIR:—

Your card of 2nd inst. came duly to hand. I am unable to give you the desired information about the species of *Alysia*. We have quite a number of specimens in our collection, but they are nearly all undetermined & as I have never studied the species, cannot say anything about them. I am now so fixed, I cannot give Entomology any attention & therefore am practically out of the field.

Decr. 19/83.

MY DEAR SIR:—

Yours of 11th inst. received. I enclose receipt for $4—for volume 10 of the "Transaction." In a day or two I expect to receive the last number (4) of the volume from the bindery, when I will mail you the volume complete.—We are now at work on volume 11, but the first number has not yet been issued. We have not done much publishing the past year on account of losing our printer, & have had much difficulty in replacing him. Now we have a good man & will get on more rapidly. Can't you send us a paper on Lepidoptera now & then? As yet we have no papers on Lepidoptera for the next volume.

There is not, at present, any likehood of me having the opportunity to resume my Entomological studies, my position here being such as to take up nearly all my time & I very seldom get to the Academy where the collections are kept. I know of no one else who can assist you in determining the Ichneumonidae. If I find, at any time, that I can name some for you I will advise you to send them on, but at this season I am kept very busy here & shall not have much leisure until after February or March.

Mch. 3rd 1885.

MY DEAR SIR:—

. . . You may send me such Ichneumonidae as you wished named & I will do the best I can to determine them. It has been so long a time since I have done anything with the study of the

family, I have become very rusty & am not posted on what has been written or described on the subject for some years. Please forward the material as soon as possible to me at S. W. corner of 19th & Race streets, Acad. of Nat. Sciences. I shall have an opportunity during this month of spending a few hours each week at the Academy & can devote a portion of the time naming your specimens. After this month, I shall be busy elsewhere & will not have an opportunity to do any Entomological work for some time.

Please arrange the specimens as nearly as you can into genera & number them consecutively so that I may be facilitated in the work of naming. Pack them very carefully putting plenty of soft elastic material between the inner and outer box & forward by express.

Apl. 18th 1885.

Friend Lintner;

Your card of 16th inst. received. I found time last week to go out to the Academy to name the Hymenoptera you sent for that purpose. But have been so busy since I could not not copy out the list until now. I enclose it here. Shall be glad to name small lots for you whenever I can find leisure to do so.

June 12th 1886.

My dear sir:—

Your card of 10th inst. received. At this present I am unable to estimate the number of described Hymenoptera of America North of Mexico, but in the paper upon which I am now engaged & which I expect soon to finish, I propose to give a list of them; I shall begin the list in a few days & will then ascertain the number of species & advise you.

If Norton will not undertake to name the Tenthredinidae for you, you may send them to me at S. W. cor. 19th & Race sts. Phila. & I will do the best I can for you.

July 2nd 1886

My dear sir:—

Your favor of 24th ultimo recd. At present I can only approximate the number of described Hymenoptera, my lists not being by any means complete. They are about as follows:

Phytophaga	573	species
Entomophaga	2166	species
Praedones	1078	species
Anthophila	633	species
Total	4450	species

Synopsis of the Hymenoptera of America, North of Mexico, 1885–1887.

After 1882, no entomological contribution appeared from his pen until 1887, when his greatest work—"Synopsis of the Families and Genera of the Hymenoptera of America north of Mexico together with a Catalogue of the described species and Bibliography" was published.[31] The story of its inception and progress are told by himself in the following letters to Dr. L. O. Howard;[32] they show also the care which Cresson bestowed upon details.

December 3d, 1885.

L. O. Howard Esq.,
Washington, D. C.

My dear Sir:—

With the hope of stimulating the study of Hymenoptera, I have concluded to endeavor to get up, this winter, a series of tables referring to the classification of that order. It will be a troublesome task and in the present condition of things cannot be else than very imperfect. To take up each family and endeavor with the aid of what has already been done to work up a new classification would be the proper course to pursue; but that would take years of hard work and more time than my health will permit me to give; therefore I shall merely gather together what has already been published on the subject and compile from that what may seem most satisfactory as far as our fauna is known. The want of a readily accessible classification has, I know well, prevented many students from taking up the study of our hymenoptera and hence we have so few who appear interested enough even to make collections. I think the publication of the tables I have referred to, will quicken an interest and thereby do good. I shall make the tables as condensed as possible, giving as briefly as I can the principal characters by which the families, etc., are separated; beginning with a table of the families and then taking up each family and divide into genera. Now as I know little or nothing of the *Chalcididae* and *Proctotrupidae*, would you help the work by contributing a classification of one or both of these families? For which of course you will receive full credit in the publication. Or, if you cannot do that, will you please advise me what published classification would be best for me to adopt? For the reasons given above there will be, as far as I am concerned, very little original work in the classification proposed, and must necessarily be a work of compilation and yet I shall do my best to make it of scientific value. As the different

families become studied and worked up, new characters will be found and made known and probably in 5 or 6 years a more satisfactory classification at least of some of the families will be published. We want more students in the field and to obtain them, I believe something must be done in the direction proposed above. Won't you assist me in the Chalcids and if possible the Proctotrupids? I hope so.

December 5th 1885.

My dear Sir:—

Many thanks for your card just received. I shall not want the MSS. before March 1st next, as it will keep me busy until then to complete the other tables. It will answer quite as well if you publish your synopsis in the *Ent. Americana* first, provided you can have it printed there by the time I shall want to use it. I shall publish the tables (as one paper) in the *Transactions* of this Society and will have a goodly number of separate copies struck off to distribute. The style will conform to that used in the *Transactions,* see enclosed leaf. I do not intend to go below genera, & shall add a few notes as to what has already been done in working up certain genera and give reference to papers published, to aid the student in studying any family or group he may desire to take up.

In the synopsis I shall include only the genera that are known to occur North of Mexico.

With sincere thanks for the promised assistance, I beg to remain.

February 10, 1886.

My dear Sir:—

Serious illness in my family has caused quite an interruption in my work on the Synopsis; but I am at it again. In sketching out a table of the families, I am much puzzled where to place *Pelecinus*, which is the only genus in the Terebrantia, as far as I know, that has one-jointed trochanters. As you are doubtless better versed in the characters of our Proctotrupidae than anyone else, I take the liberty of asking you if the characters given in the following table will, in your opinion, be sufficient to separate the Pelecinidae from the Proctotrupidae. I am obliged to follow Haliday in referring *Pelecinus* to a separate family, because I cannot make it fit in any other. Any criticisms or suggestions you may be pleased to make, will be much appreciated.

February 20, 1886.

My dear Sir:—

Many thanks for your kind favor of 18th inst. and the valuable information and suggestions contained therein. I shall do as you suggest regarding *Pelecinus.*

I am now wading through the Ichneumonidae and already feel almost discouraged; for while a practiced eye can readily separate the species into genera, it is very difficult to describe the differences and I am almost sure that, in the present condition of things, nothing satisfactory in the way of a synopsis can be given. I feel very much like ignoring many genera recognized by most continental writers, and in fact reducing the number to at least one-half. The characters in the Aculeata are better and more satisfactory as a rule.

I heard from Mrs. Patton yesterday and regretted to hear that her son (W. H.) is no better. I fear he never will be.[33]

Thanking you again for your kindness.

February 26, 1886.

My dear Sir:—

Your favor of 24th at hand. Buckley's types of Ants are not in our collection, and I do not know where they are. We have a few species determined by him, but I would not place much reliance on their correctness, as he appears to have the same weakness with our Canadian friend Provancher,[34] of mixing things up.

I shall probably not include the Formicidae in my synopsis except as a family or rather tribe—Heterogyna; as I have not succeeded yet in finding a classification that will take in the majority of the genera occuring in N. Am. and I have not time to wade through the material. Besides, I am a numscull as to that interesting and wonderful tribe. The Society's collection of Ants is very poor. Do you know of any body in this country who makes a study of them and who would probably contribute a synopsis? I hope you do.

March 24, 1886.

My dear Sir:—

Can I borrow from you the wood-cut you used in your Report on the Parasites on the Coccidae, illustrating parts of the thorax, wing and antenna? I have not made up my mind yet whether I shall illustrate the Synopsis with figures of generic characters. Should I do so, your cut would come in handy for the Chalcididae. I notice that you figure the trochanter as *uni-articulate;* have you found that so in any Chalcid or Procto-trupid as far as you know? I am working hard to get the Synopsis finished by the 1st of May and have only the evenings to work at it; about one-third of the time I feel too badly to do anything; therefore it can scarcely fail to be full of imperfections.

I am certainly most thankful to you for the aid you have given and are giving me.

July 13, 1886.

My dear Sir:—

. . . I was in hopes to have it in the printer's hands by the 1st June, and here it is almost the middle of July, and not there yet. It has proven a much larger undertaking than I anticipated, a great deal of ground to go over, much copying to do, translating Latin, German and French (at which I am not at all apt) and then condensing the matter, has required much time and labor. It will be a miracle if I escape making some notable blunders. What is the earliest date you can give me as to the completion of your tables? I am ready and waiting for them.

Trusting that you and your other half are enjoying good health and that a long life full of happiness, peace and contentment may be accorded you. I remain

July 16, 1886.

My dear Sir:—

Thank you for your very kind and prompt reply to my note of 13th. . . . However, to the point. Give as complete synopsis as you can of all the genera known of *Proctotrupidae*, by all means, and if you will go right at work at it and let me have the MS. soon, I will see that it is published *at once* in our "*Transactions*" and in advance of my "Synopsis." In the latter I shall not confine the genera to those known only in our fauna, except in the *Aculeata*. The Terebrantia have been so little studied, that foreign genera had to go in to make the tables of value. Our genera of Aculeata are tolerably well known, except the Heterogyna, a table of which I had to patch up from André principally. I asked Mayr to help me out, but he declined in such bad grace that I dropped him like a hot muffin. Knowing comparatively nothing of the family, I fear I shall make a mux of the job; however I shall expect to be severely criticized anyhow, *no matter* how hard I may try to do well; such criticisms will stimulate study, *no matter* how much they may sting me, and so good will come from the attempt *no matter* how imperfectly the work may be done.

We are out of MS. just now, for our "*Transactions*" & now would be a good time to publish any papers you may send us, as in 2 or 3 weeks Blake will have his Monograph of N. Am. Mutillidae ready for the press, after which my "Synopsis" goes in. So if you can make a short paper reviewing your *Synopsis* now in course of publication in the Ent. Am., and follow it with your Proctotrupid synopsis, we can publish both quickly, as the printer is yelling for "copy."

The "recurrent nervure" matter in the *Proctotrupidae* is important to me as I have based family division upon it. If the occurrence is frequent in the family, I shall have to revise the table; if, on the other hand, it occurs only in a few genera, I can state the exceptions and make the table do.

July 21st, 1886.

My dear Sir:—

Yours of 20th inst. at hand, and I thank you for the information you have kindly given me. I fear the occurrence of the recurrent nerve in Proctotrupidae is too frequent to except them in the synoptic table of families.

Perhaps Dr. Mayr was in a bad humor at the time he wrote me or that something annoyed him; however I do not feel vexed with him; altho I do not care now to trouble him in helping me out. The tables I shall give will doubtless be supplanted by such as he may give in the work which I understand he is writing on our N. Am. genera & species. I wish it could be published before mine. I regret to tell you that neither the Academy of Nat. Sciences or Entom. Society possess a copy of Haliday's Hym. Synopsis. I have ordered a copy for our library, but as it is scarce, it may be a long time before we shall get it. Should it come, I will at once send you a transcript of the portion you desire.

Will have your Proctotrupid paper put in hand as soon as received, i. e. if it comes before Blakes' paper is begun, which cannot be ready before last of next week. Please endeavor to hurry Smith in the completion of your Chalcid paper.

July 30, 1886.

Friend Howard:—

Yours of 28th with MS. of Proctotrupid. Synopsis at hand, & is now in hands of the printer. Proof in a few days. Hope either you or I will hear from Europe with copy of or extract from Haliday's Synopsis, in time to give the characters of Bethylinae at least in my paper. If not, then it will have to go as it is. Please favor me with a copy of your Chalcid Synopsis as soon as you can so that I may prepare it to add to my paper, which I want to have ready to slide in as soon as the printer has finished Blake's Mutillidae. If I am not ready then, I may not have a chance for months, as Dr. Horn is piling up MS. very rapidly.

The specimen of *Helorus* I sent you seems to tally with Provancher's *Copelus* (n. gen.) *paradoxus* see Nat. Can. xii, 207, figures. Please look at this. If this is so, a change in your remarks under that genus will be necessary. This you can do when you get proof. Our reverend friend has been singularly unfortunate in his new genera, owing doubtless to want of the necessary literature. One of his genera is composed of *males* of *two* well known genera, mistaking one of the males for the opposite sex. I assisted him some time ago to straighten out some of his n. sp. of Ichneumonidae, awfully mixed up; but since then he has published a large batch of species which will be a job for some one to work over. I never expect to attempt it, unless he loans me his types.

August 2, 1886.

FRIEND HOWARD:—

Herewith please find proofs of Proctotrupid Synopsis. It makes about 10 pages. Please return one with corrections & retain the other. Don't forget to say how many extra copies you desire. What have you done with *Scleroderma* & allied genera? Most authors place them in the Proctotrupidae & I have not made provision for them elsewhere in my synopsis. I must place them somewhere. Westwood describes several species from N. Am. in his "Thesaurus."

When you write me again, please tell me if the genera of Proctotrupidae having a recurrent nervure, *have any of them veined under wings*. You see I am yet on the search for characters for my table of families, and not being acquainted with the Proctotrupids I am sailing under difficulties & feel obliged to bother you.

As to throwing the onus on me in reference to Bethylinae, in your preface; I don't care a picayune about the onus, but I have an aversion, perhaps a foolish one, to seeing my name in print, and it has been used pretty often lately especially by friend Ashmead.[35] I must say I would rather it be not used unless necessarily. By saying that you have been advised not to defer the publication of the synopsis on account of, etc., would answer quite as well without using my name, & if you should be asked who did advise you, then you could say—. Do as you please however. I hope, however, that before the printer reaches the family in my paper you will have heard from Riley[36] with a copy of the paper. If you do please fail not to add the characters to a copy of your paper & let me have it.

I see the printer has run short of Cap G & F but these will be made right before printing.

August 10, 1886.

MY DEAR SIR:—

I come to bother you again. In making a list of the described species of Hymenoptera N. of Mex. to append to the Synopsis of Genera I propose to publish, I have arrived at the Proctotrupidae. On enclosed slip I have written such as I have been able to find. If you know that any of the species are referred to other genera than those given, will you kindly note the proper genera on the space left after each species. I desire to have the list as nearly complete as possible. I do not find *Coptera* & *Serlion* in your Synopsis, & presume the species belong to other genera.

I am running against snags every little while, & because of ignorance or the want of information in some of the families. I get much perplexed, & feel like chucking the whole thing in a drawer never to look at it again. I become thoroughly disgusted with the characters given in many cases, especially in the Ichneumonidae, the most perplexing family in the entire order; yet there must be valid characters somewhere, but they have not been found; when found we shall wonder where our eyes & senses have been not to have discovered them before.

By the by, in the characters given of genus *Mystrophus* (in *Dryininae*) should not the second "*mesonotum*" read "*mesoscutum*" to conform with next alternate? I noticed this in copying for my paper.

Excuse me for bothering you so much. Please return enclosed list when you have made your notes. If I have omitted any described species, please add them with the reference.

When you are ready to look over the Society's material in Chalc. & Proctotrup. (not extensive) I will forward to you.

August 12, 1886.

FRIEND HOWARD:—

Don't forget, please, to let me know whether you find any Prototrupids having a recurrent nervure & at same time veined posterior wings; if you do find any I shall be snagged again.

I am endeavoring to patch up a table of the genera of the *Anthophila* so that they may be distinguished from external characters. To be obliged to dissect the mouth parts in order to ascertain the genus would discourage almost any new beginner. I expect that when I get the whole thing cooked nicely, I shall run against something that will hash the whole business.

August 20, 1886.

FRIEND HOWARD:—

I regret that my letter has been mislaid, as I really forget now all that I wrote about. I ask numerous questions, enough almost to provoke you into silence; but like one of my boys, when I said to him, "why do you ask me so many questions?", replied "*because I want to know*"; & so I am like him, seeking information, & I don't know of anyone else in this country who can give that information to me but yourself; hence the reason why I bore, bother & annoy you so often. I will now try to think out what I wrote you in my last letter. . . . .

Sept. 23, 1886.

My dear Sir:-

Your valued favor of 21st is received. I do feel most grateful to you for the trouble you have taken and the valuable time you have given me in this matter, & I feel sorry that I bored you so much, my only aim being to have the synopsis as complete as our imperfect knowledge of characters will permit. As I said before, I wish to conclude the paper with a list of the species that have been described as found N. of Mexico, & it is to explain if possible the presence of genera in the list, not found characterised in the synopsis, that I questioned you on so many points. I shall probably now be able, through your kindness to make out tolerably well. The synopsis of the Chalcididae & Proctotrupidae in my paper will be an almost verbatim copy of yours; so if you have any corrections or additions to suggest, please let me know. I suppose you have heard nothing further as to the characters of the Bethylinae, & that the synopsis will have to go in without that subfamily being characterised. Could you not supply those characters by the examination of specimens? I will most gladly send you, at once, all the material we have, if you will have time to examine them with that view. The printer will hardly reach the Proctotrupidae in my paper before the 2nd week of October. We have made a vain attempt to obtain a copy of Haliday's Synopsis, from our Agents in Europe. It seems to be exceedingly rare. Trusting that you have recovered your usual health, & with renewed thanks for your kindness in assisting me in my work, I remain as ever.

October 2, 1886.

My dear Sir:—

Having had occasion to go out to the Academy yesterday, I picked out all the Bethylinae I could find, only 32 specimens, which I send you today by express, prepaid, addressed to you at the Dept. of Agric. As the printer will not be ready to tackle my MSS. until last of next week, I am in hopes you will be able to find leisure to examine the specimens & perhaps suggest characters for the separation of the subfamilies. I also send my MSS. list of the Chalcididae & Proctotrupidae to compare with your own. If you find any errors or omissions please kindly correct & add & I shall be ever obliged to you. When you get through, please return the whole. . . . I have not had time yet to verify the references etc. in the list, but intend to before being printed. I have found out that *Serlion* is a typographical error for *Scelion* the french of *Scelio*. & have referred Say's species accordingly. In transferring the Bethylinae to the little box I was reminded forcibly of their resemblance to certain Scoliidae, as suggested by Westwood, Haliday, etc., but have not had time to examine them

with a lens. If they have biarticulate trochanters they are Proctotrupids, if uniarticulate, then, what? They are either a rare exception to the rule, like *Pelecinus*, or else they belong to the Scoliidae, which however have the middle coxae well separated and the middle tibiae (except female *Myzine*) with only *one* apical spur. How is this in *Bethylus*? Please see. Following after Hartig, I have divided the families of Hymenoptera into two grand divisions. *Post. trochanters 1-jointed, & 2-jointed*, the former including the Tenthredinidae, Uroceidae, Cynipidae, Evaniidae, Ichneumonidae, Braconidae, Chalcididae & Proctotrupidae; & the latter division containing the Pelecinidae, Chrysididae, Formicidae & the remaining families. There may be exceptions to this rule in some of the Chalcids and Proctotrupids but I know of none in the other families. *Pelecinus* looks as if it ought to belong to the *ditrocha*, but it certainly has 1-jointed trochanters. I however place it in the series *Parasitica* as an exception. It is certain that a really satisfactory classification cannot be had with our present imperfect knowledge of characters, and it is probable that after a careful study of the whole business the tables of characters offered in my paper will be knocked into pie & of little or no value.

I enclose a letter just received from André who has been trying to find a copy of Haliday's Synopsis for me. He copies table from H's Oxyura which however is here in our Library & which refers the Bethylinae to the Fossores. Please return André's letter when done with or when you write again—no hurry.

Sorry to be boring you again.

October 7th, 1886.

My dear Sir:—

Your favor of 5th inst. also package have been duly received & I sincerely thank you for the trouble you have taken in my behalf.

I know nothing of Ashmead's facilities for the study of Cynipidae; there is no doubt however that he knows a great deal more than I know of that family, as I have never paid any attention to it; his synopsis may be very faulty, but as it is the only one I can obtain for our genera, I can do nothing else but copy it. Some months ago I wrote to Bassett[37] for assistance in the matter, but for some reason I did not even receive a reply to my note. I presume he is away somewhere. I am not aware that Ashmead is preparing a list of the Cynipidae for me, for I have one already prepared, but I wrote him some weeks ago as to where *Hexaplexa* (or something like it) would be placed in his tables, since a species of that genus has been described as occuring in our fauna. If he is unable to characterize it, I shall leave it out. I feel deeply sensible of the crudeness & imperfec-

tion of the Synopsis as a whole, & heartily wish I never attempted it, but it is now finished & will have to go for what it is worth.

Desiring for your health, & peace & the consumation of every good wish you may have, I beg to remain.

November 2nd, 1886

FRIEND HOWARD:—

In order not to interfere with the regular publication of the Transactions of the Am. Ent. Soc., the Pub. Com. has decided to publish the Synopsis separately as an intercalary volume. I cannot tell now when its publication will be completed, as the Transactions have the right of way. However I shall push it all I can. Had I known that it would have been published separately, I would not have been so skimp or in in other words not cut my cloth so close, or boiled it down so much. It will have to go as it is, for I cannot give any more time to it.

November 6th, 1886.

FRIEND HOWARD:-

I'm bothering you again. Will you kindly see if I have a list of all the papers you have published concerning our hymenoptera, on the enclosed sheet, & if not to add the titles, etc., of such as I have omitted? I want to give a full list of all that has been published, to follow the list of described species.

I am writing one out for Mr. Riley to look over, of his papers, of which I suspect I have not one-half.

I think a list of such papers will be useful to the student of Hymenoptera.

Can you give me an idea what *Cook's "Practical Entomologist,"* quoted in the Zoological Record is, & in which you published the description of *Pachyneuron altiscuta*? I wrote Cook to send me a copy of it & he kindly sent me a copy of his pamphlet on Injurious Insects, etc., published in *1874*, which he said was what I wanted, but I do not find that species mentioned anywheres in it. Has he not published another pamphlet of the kind? The publication of new species in newspapers & obscure pamphlets, which soon get out of print is going to give the student of the future a deal of trouble. In 1877 a certain La Munyon of North Platte Neb. published (at least I judge so from a separate in our Library) a short paper in the Proc. Nebr. Assoc. Adv. Science describing a new genus of Braconidae, & three species. I have written 6 or 8 parties in Nebraska to ascertain whether there is such a publication & whether the paper was ever pubiished, & altho I enclosed stamps for reply, not a single one of them took any notice of me. If our study was about Elephants, or bones or stones, perhaps I would have heard from all of them. So it goes. As ever,

November 9, 1886.

. . . . .

Many thanks for your kind favor of 8th, with list & additions & also separata. I have written Cook & also Bruner and hope to be able to solve both matters ere a fortnight passes. I am now in the midst of verifying references in the list of species, a very tedious, tiresome task. I must have it made reliable if I can do so.

November 19, 1886.

FRIEND HOWARD:—

On looking over the MS. of the list of Chalcididae, to be appended to the Synopsis, & which you very kindly revised for me, I notice that at the end of the reference to *Encyrtus flaccus* Walk. you have added *Cerchysius*, by which I presume you mean that it is referable to that genus. I do not, however, find *Cerchysius* characterised in your Synopsis of the family. Please advise me what to do in this case. If not characterised, why make the reference? It may be synonymous with one of the genera you have in the synopsis & if so please put me straight. Since you ret'd. the MS. List of Chalcididae, I have found several omissions. The references in Ashmead's List of Cynipidae is full of errors. The task of verifying the references in my list of Hymenoptera is a very formidable one, but I must perform it wherever I can. By the way, in looking over Ashmead's paper in Proc. Ent. Sec. A. N. S. 1885, xvi, I see he describes three species as belonging to *Eupelmus*, but which are evidently meant to be *Encyrtus*, judging from the headings at top of the page: probably an oversight in proof reading. Can you tell from the descriptions whether they belong to *Encyrtus* or *Eupelmus?* The publication of the Synopsis is still delayed, so if you are yet able to characterize the Bethylinae, please let me hear from you. It's a pity to leave them out of the subfamily table. It will be a fortnight yet ere the printer will reach the Proctotrupidae. Hope you are well and happy.

November 27, 1886.

FRIEND HOWARD:—

Yours of 26th (2) received. Glad you have settled the "*Elaptus*" matter. According to a letter I have from Forbes, it appears that he intended "*Elaptus*" as a new genus of his own, with *aleurodis* as the type, but neglected to indicate the generic characters. Strange that he should have hit the right genus all but one (the first) letter, isn't it? The specimens of parasites on *H. textor* have not yet come along, but they will receive prompt attention when they do. You have been so kind and helpful to me in the compilation of that part of the Synopsis refering to your specialty, that I shall want you to command me without hesitation whenever I can be of any service to you.

satisfactory one, at least to me, because of the crudeness and the imperfections of my work." Considering what a great gap this work filled in the literature of North American Hymenoptera and entomology in general, it is surprising that its publication attracted so little comment in the contemporary journals. A search therein has yielded only one review, that by the Reverend George D. Hulst, lepidopterist and editor of "Entomologica Americana." Writing in the latter for July, 1887, he said:

> The above work, part I of which is completed and lies before us, marks an era in the mapping out of another part of the great field of American Entomology. One by one specialists are bringing facts, which are chaos to the ignorant, into order, by the ascertaining and publishing of the relations and likenesses which reveal the unity in diversity of Nature. And of this task, no little portion is set before us in the above work. Mr. Cresson is the more worthy our thanks, as his labors have been in what is one of the most difficult of all suborders. With this work in the possession of the student, he can with little difficulty arrange his Hymenoptera in their proper families and genera. We can not too highly recommend its use to those whose taste leads them to collect and to strive after a scientific knowledge of the Hymenoptera.

The "Synopsis" did, however, soon provoke a reaction from an active hymenopterist to whom Cresson frquently referred in his letters to Howard. At the meeting of the Entomological Society of Washington on October 6, 1887, Mr. Wm. H. Ashmead read a paper entitled "A Proposed Natural Arrangement of the Hymenopterous Families" and went on to remark:

> A natural arrangement of the divisions and families of the Hymenoptera according to my views, differs so materially from that proposed by Mr. E. T. Cresson in his recent excellent work "Synopsis of the Families and Genera of the N.A. Hymenoptera" that this early opportunity is taken to draw attention to them while that work is fresh before the entomological world. The division of the order into 2 sections—*Hymen. ditrocha* and *Hymen. monotrocha*—is, I think, a natural one; but the arrangement of the families by Mr. Cresson is, in some respects, very unnatural, and fails to show their relationship.[38]

For thirty years Cresson's "Synopsis" remained the only complete handbook to the North American Hymenoptera. In 1916, a composite work by H. L. Viereck and collaborators under the editorship of Dr. W. E. Britton, "The Hymenoptera of Connecticut," appeared to supplement the "Synopsis," but it is indicative of the great value of Cresson's work to find an English author, in an excellent general text-book of Entomology, of 1925,

in dealing with the venation of the Hymenoptera, expressing himself as follows: "It has, therefore, been deemed desirable to offer an alternative terminology, (that largely used by Cresson) . . . . which also affords greater facilities for reference and has been adopted in the keys to the families."[39]

Later Work on Hymenoptera

Cresson had written to Howard on at least two occasions (December 6, 1886, and August 10, 1887) that when he was through with his "Synopsis" he would probably do little or no more describing or work of that sort but would confine himself to the rearrangement of the Society's collections. He adhered quite closely to this declaration. The only notable exception was his "Descriptions of some Mutilla from Brazil" (1902).[40] This deals with a collection made by the late H. H. Smith which Cresson's son, George B. Cresson, had undertaken to study. As this plan was not executed, Cresson took it into his hands to fulfill. He did, however, strive to answer taxonomic questions for his old correspondents, answering some queries from Lintner as follows:

Dec. 18, 1889.

Prof. J. A. Lintner,
My dear sir:—

Your postal of Nov. 26th came duly & also copy of your report for which I thank you. I can remember that many years ago, when I first knew what a *Polistes* was, our common species was known as *fuscatus* Fabr. I have never looked up the subject very carefully, nor have I attempted to separate our species of that genus; but when making out the list to accompany my Synopsis, I was unable to find that Fabricus ever described a species of *Polistes* by the name of fuscatus. The first chance, I have, however, I will try to ascertain where the name has been quoted & how we happened to get it. The species labelled by that name in collections seems to be our common *pallipes* Say. The genus needs a thorough revision as the species are in confusion & no doubt too numerous. The proper way to ascertain the extent of variation of a species is to capture the nests and their contents. Wish some one conveniently situated would undertake such a work.

Please aid us if you can, & whenever you can, with short notes and news for our new journal. Anything of interest to students of Entomology will be very acceptable. Please do what you can to help us make the "News" what it should be.

[The last paragraph refers to the beginning of "Entomological News."]

Oct. 28, 1890.

My Dear sir:—

Your favor of 15th inst. with enclosures duly recd. but press of business has prevented a more prompt reply. I shall be quite unable to give an opinion on the subject of your letter without a comparison of specimens. I am not acquainted with either of the species you speak of. *Viminalis* is doubtless a *Cladius*, as the genus is well established in Europe, but I cannot say that *lubescens* belongs to *Aulacomerus* without an examination of specimens. Since venation is so prone to vary in many of our saw-flies, I question the propriety of making genera on such variable characters; hence I think that the Tenthredinidae need a thorough study and revision. Except in a general way, I have not studied them closely, but know that in consequence of variable venation I have frequently been at a loss to place a specimen generically. As to the identity of quite a number of our species with wellknown ones in Europe, I have not the least doubt of it & I feel that good & correct work cannot be done without having first a good collection of European species for comparison with our own. Unfortunately we have not such in Philad. As *Aulacomerus* seems to be founded upon a difference of venation, it may not amount to anything; the same may be said of several other so-called genera. In these cases, I apprehend, that nothing short of a study of the life-history & habits of the species will decide their correct position. I return you the letters & feel sorry that I am unable to give you the light you desire.

On June 15, 1903, the late Mr. G. C. Champion, of the "Biologia Centrali-Americana," wrote me inquiring about Cresson, saying, "We have some Mexican Ichneumonidae he might like to see?" On communicating this to Mr. Cresson he replied:

Much as I would like to dabble again in parasitic hymenoptera I am afraid to undertake to work at them on account of my rustiness; not having done anything with them for so many years, I would have to read up and study over the work done in the interim, before I could do intelligent work among them. You know how it is; and when you have occasion to write Mr. Champion again, please tell him that I am greatly obliged to him for the offer, but am unable to undertake the work. (July 3, 1903.)

One reason at least for the rather abrupt cessation of taxonomic work on Cresson's part at the age of forty-nine is to be found in some partial failure of his eyesight, due probably to the night work under gas light, to which he referred in his letter of January 11, 1872, to Belfrage (*antea* page xx).

Ten years before the close of his life, he provided for his fellow laborers, present and future, a complete index to his own taxonomic work. This was entitled "The Cresson Types of Hymenoptera" (1916).[41] This memoir of 141 pages consists (1) of a list of the types of the species he described as new, arranged alphabetically under each family, 132 pages; (2) a list of his entomological writings, 1861–1911, 70 in all,* sixty-eight of them on the Hymenoptera, 6 pages; (3) an alphabetical Index to the families included or referred to in parts 1 and 2. The number of species represented in the list of types is given as 2737. This considerably exceeds the 1582 species of Coleoptera described as new by Cresson's contemporary and fellow member, George H. Horn,[42] although both fall far short of the 4739 new species credited to LeConte.[43] The list of Horn's entomological writings is much greater—running to 265, long and short, and extends from 1860 to 1896, ceasing within thirteen months of his death in his fifty-eighth year.[44] No attempt has been made to determine the number of printed pages of the respective authors.

On November 15, 1919, Cresson wrote to Mr. H. L. Viereck:

> I am engaged in getting together the data etc. of all types of the Hymenoptera in the collection here at the Academy—other than the "Cresson types"—with the intention of publishing the list in the "Memoirs" of the Society in the coming spring, in same manner and style as the "Cresson types." This will complete my entomological work on this plane, and am asking if you will assist me as far as your many types are concerned. . . ."

Cresson completed the rough manuscript of this projected list as to make it possible to publish it in the near future.

Later Work for the Society

But if his labors as a publishing entomologist nearly ceased in 1887, his interest in his beloved Society remained almost as active as ever. He continued as Treasurer until 1924 and numerous are the letters on the financial affairs of the association which he addressed to the other officers. As chairman of the Publication Committee and editor of the Transactions until 1914, he saw the latter reach the thirty-ninth volume and in 1889 he

* Two omissions, known to us, bring the totals to seventy-two and seventy respectively. References to them will be found in note 25.

presented a report to the Society advising the establishment of *Entomological News*.[45] He served as Treasurer for the *News* for seven years, doing "the entire work of getting out the journal . . . . or in other words the large amount of necessary labor, except that of editing."[46]

In 1901 he presented his Collection of Hymenoptera to the Society, comprising 2367 types and 3511 species and the number of specimens was estimated at 87,775.[47]

At the request of the Society he prepared a history thereof, which was read at the fiftieth anniversary meeting on February 15, 1909. On that occasion his portrait was presented and hung in the Society's rooms at the Academy of Natural Sciences and the following resolution was unanimously adopted:

> "The American Entomological Society . . . . especially rejoices in the presence to-night of one of the three founders of the Society, Mr. E. T. Cresson, who from the very first has continuously exerted himself in its interests, serving as treasurer for thirty-five years, as editor of the Proceedings, later Transactions, for thirty-eight years, and who, during the early days of the Society's existence, cared for its collections and library and with his own hands set type for its publications, besides composing long series of Entomological memoirs, principally upon the Hymenoptera, which have given to him and to the Society an honorable distinction, both at home and abroad. To many a younger student he has kindly given his aid, his advice and his example. He has encouraged and furthered the progress of Entomology in the United States far beyond the limits of his home by his activity as author and by his gift of his most important, valuable and extensive collection of Hymenoptera to this Society. Thankful for all his unceasing labors, this Society now places upon its records, in his presence, its deep appreciation of his services and extends to him its best wishes for many additional years of life and happiness in that field of science which he has cultivated so long and so well."[48]

In later years, his appearance at the meetings of the Entomological Section of the Academy of Natural Sciences or of the American Entomological Society was rare he could usually be expected to be present at the December meetings and read the annual reports of the Treasurer and Publication Committee, but even the writer's recollections, reaching back to 1887, do not

recall him as making communications, verbal or otherwise, upon insects. As far as one may judge from the printed minutes, the meetings of 1879 seem to record the golden days of the Entomological Section with John L. LeConte in the chair and Horn, Cresson, McCook and Blake as frequent speakers.[49]

At the Society's meeting of October 23, 1924, a letter was read from him requesting that he be relieved of his duties as Treasurer, whereupon the following resolution was unanimously carried:

> The American Entomological Society hears, with deep regret, the letter from the Treasurer, Mr. E. T. Cresson, dated October 20, 1924, requesting that he be relieved of his office. This Society looks on Mr. Cresson as its founder. It recalls the sixty-five years which he devoted to its welfare as a member of its Publication Committee, as Editor of its Transactions and as Treasurer, the last for fifty consecutive years. His services have been given without salary or pecuniary reward. In acceding to Mr. Cresson's request, this Society desires to place upon record its appreciation of his unselfish and untiring labors in its behalf, its pride in his long connection with the Society and in his numerous contributions to Entomology and its best wishes that he may long remain with us as our most honored member.[50]

On March 26, 1925, the Society elected him an honorary member; the first under the revised by-laws providing for such special membership.[51]

Honorary membership had come to him from the Entomological Society of Ontario on November 10, 1868, the California Academy of Sciences on January 3, 1888, the Entomological Society of America on August 21 1907 and the Second International Congress of Entomology at Oxford, England, in 1912,[52] and he had been elected a Corresponding Member of the Essex Institute May 1, 1862, and of the New York Entomological Society, November 2, 1872.

Last Years

On August 18, 1887, Cresson wrote to L. O. Howard:—

> . . . I live some 10 miles out of the city, in plain informal country fashion, & if you can put up with such you will be welcome. I left the city some five years ago to try a home in the country, principally on account of my children, of whom I have five. Their health has been so much benefited by the change, we expect to remain country-folk until the little ones grow up. Let me know a day or two before you come on. I shall be very glad to see you, if only for a short time, should your visit be brief.
> My office is at No. 421 Walnut St.

November 30, 1886.

FRIEND HOWARD:—

I have examined the Ichneumonid parasites on *Hypantria textor* & regret that I cannot determine them definitely. Our collection of the smaller ichneumonidae is in confusion & sadly needs a thorough overhauling & arranging. However I am anxious to do the best I can for you. . . .

Now this is really the best I can do. Unless Provancher has described these species, they are without doubt undescribed. Our reverend friend has made such a mess of the parasitica & in fact of all the order, in his papers on the subject, that it will be a long vexatious task to straighten out his work, unless one can obtain his types for comparison.

Shortly after his first papers (on Sawflies & ichneumons) had been published, I induced him to send me his types & I found his determinations mostly wide of the mark. I took pity on him, & after considerable work straightened them out for him & returned the specimens. Shortly afterwards, he published the corrections in the Can. Nat. & without even saying "thank you" for pulling him out of the ditch. He has published a great mass of things since & I expect they are in the same mess. Lately, I begged him to stop his manufacture of genera & species until I was able to send him a copy of the synopsis, so that he could approximate to the correct genera; but it riled him considerably & he fired back by saying that the readers of his journal could not afford to wait. The only danger is that he will overstock the market & ultimately [be] an entomological failure. He has evidently undertaken the work without the necessary machinery.

I will return the Ichneumonids tomorrow. Am too busy to do more or write more Entomologically to-day, & must now go to work at office business until five o'clock & then go twelve miles to reach home.

My kind regards to Prof. Riley.

December 6, 1886.

FRIEND HOWARD:—

Glad to hear that Prof. Riley intends to continue work on the Hymenoptera, & I hope the number of votaries will increase. After I get through with the Synopsis I expect to confine myself to the rearrangement of the collections of the Society & will probably do little or no more describing or work of that kind. I have about done my share.

January 13, 1887.

My dear Sir:-

I have been kept so busy at my daily vocation, I could not get time to send you the sheets of the Synopsis, as they come from the press, until now. I enclose 5 signatures, so far as printed, & should you see any blunders, please favor me with a mem. so that I may notice in the errata. I have not been able to read the proofs with the care I should have taken, because of press of other business, & so I have doubtless overlooked some errors typographical or otherwise, which you will readily discover. I hope to get the Synopsis proper into 120 pages about. Expect we shall reach the Chalcids in about 10 days, so if you have anything new to communicate, don't fail to advise me in time. The cuts are very clumsy & some too large. I am a poor hand at such work & should have gone to a first class artist; but then the whole work is imperfect & probably not deserving of better illustrations.

I am so hurried by other work, you must excuse my haste now.

The preface will not be printed until the last, as I may desire to refer to something that does not now occur to me. Should you have occasion for adverse criticism, be not afraid & do not hesitate to give them.

March 21, 1887.

Friend Howard:—

I send you the remaining signatures of the *Synopsis* proper. Please advise me of any errata you may notice, as we have concluded to issue the work in two parts, the first containing *Tribes & Genera* and the second the *Catalogue & Bibli graphy*, this latter will not be finished until autumn. A bibliographical list of the genera will close part 1, as sort of an index. The publication is slow; it costs money & we are not wealthy.

March 26th, 1887.

My dear Sir:—

. . . . Sub-rosa:—Our friend Provancher has begged so hard for advanced sheets of the Synopsis, that I have sent him a set. Now look out for a lively time in the pages of the Nat. Can., as three-fourths of his generic determinations are wrong, owing I have no doubt to the almost universal want of the proper literature on the subject. I hope now that he will be happy, in being more fortunate in his determinations, & that he will go to work & correct his mistakes before others do it for him.

May 5, 1887.

FRIEND HOWARD:—

Herewith please find copy of signatures 18, 19 & 20, which are all that have been published. I have lost all interest in the work because of the slowness with which it is being published. I have not the least idea when the end will be reached & for this reason we will issue in two parts, the first the *Synopsis* proper & then the Catalogue of Species & Bibliography. The Errata slip is only temporary, so if you see any that have escaped my notice please advise me & oblige.

August 10, 1887.

MY DEAR SIR:—

Your favor of — date received; I have mailed you copy of sig. 21-30 incl; sig. 31 has been printed, but the printer has not yet sent me copies; will mail you a copy as soon as I get one. Page 248 completes the Proctotrupidae with the exception of a few species. The Formicidae are now being put in type, & I presume that page 300 will about conclude the catalogue. I believe I had sent you the signatures to 20 incl. & intended to send you the rest as soon as I had reached the end of the Proctotrupidae, which would include the families in which you were most interested. Of course the catalogue is, & must necessarily be very crude, and when the species have been studied & referred to their proper places, the present catalogue will be a total wreck. I have no doubt that three-fourths of Provancher's species are wrongly placed, but I could not undertake to verify them, which could scarcely be done without examination of his types. Neither have I had time to examine my own species to ascertain if they are in all cases referred to the proper genera; & so you see the catalogue is valuable only as a record of what have been described, & as to this I believe it to be approximately complete up to time of printing. Whatever I have omitted or is published subsequently (as far as comes to my notice) I will add at the conclusion of the catalogue. As to the habitat "Can.", in most cases this has been given on the authority of Provancher, but without knowing that his determinations of previously described species are correct. All these matters will have to be ascertained later on. Send me the ichneumonids you wish me to see, & I will do my best for you, altho I have been getting very rusty, and our collection of parasites is in a very confused condition. I am only waiting for cooler weather to begin a rearrangement of our collections of Hym. besides which I expect to do nothing entomologically. So its probable that for the next 4 or 5 years I shall be occupied with such work & if life is spared to me & health given me I hope to make a fairly good job of it. I don't think, however, that there are many species of parasites in the collection labelled as to their hosts. Of course there

are a few & I will look over them & advise you or send them to you to look at. By the way, you said once that you would like to examine our material of Chalcididae & Proctotrupidae. How soon can you undertake them? I ask this because (sub-rosa) our friend Ashmead has written that he proposes to visit us early this autumn to look over our "Cynipidae, Chalcididae & Proctotrupidae." Perhaps you would prefer to see our material of the last two families first; & I am willing to send them to you if you can give the time to examine them soon. We have only about a double book box full, & very few labelled, except what Ashmead has given us. He has been very liberal to us & has sent us types of his species whenever he has specimens to spare. I hope you will do likewise,—so that after while we shall have a collection worth seeing.

Your record of bred parasites of the world will be a very valuable desideratum & I trust that nothing will prevent you from completing it.

August 31st 1887.

My dear Sir:—

. . . . I am in trouble again. The printer has botched signature 33, & the first two pages will have to be reprinted. He ran out of sorts & had to use turned letters in the proof & altho I marked them plainly, he turned up the wrong letters & made a mess of it. Its his loss however, but I fear other blunders have been made in the same way. I believe I am getting greyer over this task, and have a dozen times determined to abandon the study as soon as the plagued thing is out of the way.

November 15, 1887.

Yours of the 13th inst. received. I was under the impression that I had sent you sig. 33–36, & consequently sent all the over sheets I had out to the Academy. However I send you sig. 37 to end, today & will obtain 33–36 next time I go to Academy & forward to you. The job is done & I am glad of it. How crude & imperfect it really is, will be ascertained from the use of it. If it will only be the means of inducing some one to give us a better one in the near future, I shall be glad. One thing is certain I shall never start another. Will send you a complete copy as soon as the binder gets through. What is the matter with Ashmead? Have not heard.

With the publication of the "Synopsis", the plan which Cresson had sketched in 1861 was executed, although of the "Synopsis" itself he wrote to Lintner on March 4, 1887: "It has been a long, tedious, & vexatious task, & I regret to say not a

The residence which he set up in the Spring of 1883 was at Swarthmore, Delaware County, Pennsylvania and here he continued to live until his death. His wife died Dec. 8, 1909 and after that event he dwelt first with one then with another of his married children. He had four sons and one daughter: George Bringhurst, Emma, Warder, Ezra Townsend Jr., and William James. George B. was curator of the American Entomological Society 1879–1881, 1888–1889 and librarian 1892–1896 and specialized on ants.[53] Ezra, Jr., has been librarian of the Society since 1906, assistant to the Curators of the Academy of Natural Sciences of Philadelphia 1910–1923 and Assistant Curator of Entomology since 1924. His papers on the Diptera are well known.

In 1925 and 1926 the infirmities of age increased steadily but he continued to appear at the Franklin Fire Insurance Company's office. His last visit to the Entomological Society's rooms was a few months before his death. He passed away at the house of his son Ezra T. Cresson, Jr., on April 19, 1926.

Contact with Other Entomologists

As a working hymenopterist and an active official of the Entomological Society, Cresson came into contact, chiefly through correspondence, with many American entomologists. In addition to those who have been mentioned in the earlier pages of this memoir, references are made in his published papers and elsewhere to Homer D. Bassett, of Waterbury Connecticut, who eventually, through Cresson's suggestion, was led to present his valuable collection of Cynipidae to the American Entomological Society;[54] Henry Ulke, Thos. B. Ashton of Kansas, Edward Norton of Connecticut, Augustus R. Grote, William Wenzel, James Angus, Alpheus S. Packard, F. G. Sanborn, Dr. Samuel Lewis, who, while accompanying the survey of the Pacific Railway, made a collection of Hymenoptera in New Mexico on which Cresson wrote a short paper in 1868;[55] Johnson Pettie, of Grimsby Ontario; Wm. Couper, of Quebec; H. K. Morrison, Henry Edwards, F. H. Snow of Kansas, A. R. Crotch and Dr. Edwin C. VanDyke of the University of California. Cresson proposed the name *Grotea* for a new genus of North American Ichneumonids in 1864.[56] Grote and Robinson in their "Synonymical Catalogue of North American Sphingidae" (1865) returned the compliment

in "*Cressonia*, nov. gen. We name this hitherto undetected Sphingid genus after Ezra T. Cresson of Philadelphia whose sterling merit as an Entomologist we acknowledge and for whose kindness as a friend we have reasons to be grateful."[57]

General Summary of Cresson's Work

In summing up Cresson's work it is evident that by his kindliness, persistence, methodical habits and attention to detail he furnished the nucleus around whom those of his associates interested in insects could and would gather and so form an active working unit—the entomological society which he helped to found—and this may really constitute his chief service to science. Beyond this he was a student of the taxonomy of the adult Hymenoptera. He has left nothing on the early stages or life histories of these insects, on their habits, their architecture, or on any of the instinctive or intelligent acts which raise them above most of the members of their class.

The very year in which Cresson and his two associates founded their entomological society in Philadelphia saw the publication of Darwin's "*Origin of Species.*" The evolutionary ideas for which it stood affected, more or less, all four of the great Philadelphia naturalists who were, for varying periods, fellow-members of Cresson in the Society: Joseph Leidy and John L. LeConte, fifteen and thirteen years respectively older than Cresson, George H. Horn and Edward D. Cope, each two years younger than he.[58] But one searches in vain, in any of Cresson's published writings, for the slightest reference to the burning question of his time—the fixity or the transformism of species. Yet he probably set into type with his own hands the evolutionary speculations of Benjamin D. Walsh, correspondent of Darwin, which are contained in five papers in the second, third, and fifth volumes of the "Proceedings of the Entomological Society of Philadelphia."

The value of Cresson's work as a hymenopterist can, of course, best be determined by the specialists in that order of insects. It is a great satisfaction to be able to add the following estimates by some of his co-laborers in hymenopterology, most of which have been furnished at our request.

Estimates of Cresson's Hymenopterological Work by Specialists

Prof. H. T. Fernald wrote, June 7, 1926:

It seems to me that he was really the finest Hymenopterist this country has ever seen, and while with our advance of knowledge of the group, we have, of necessity, gone far away from his keys, they still stand, to my mind, as the most satisfactory ones which have ever been prepared for the group. Whether it would have been possible for him to include our present numerous species and keep them clear, is perhaps a question, but I have never worked with keys which were so satisfactory and easy to understand as those he constructed. His descriptions too were delightful in their clarity and simplicity, and it is a never-ending regret to me that we seem to have to-day no Hymenopterist capable of writing in quite as clear and comprehensible a style.

A Note on E. T. Cresson, Sr.

BY S. A. ROHWER

Bureau of Entomology, Washington, D. C.

Among the students of American Hymenoptera there have been comparatively few who have attempted to cover practically the entire order. Two outstanding workers who have covered a large portion of the order are the late E. T. Cresson and the late W. H. Ashmead. Both of these workers have greatly influenced the work of others and both have done much to advance the study of Hymenoptera. Ashmead devoted special attention to the minute parasitic forms, while Cresson's studies dealt with the larger species in both the aculeates and the parasitic groups. Ashmead did a great deal of original work on the classification of Hymenoptera and, besides preparing a new generic classification which was largely original, characterized over six hundred genera. Cresson, on the other hand, was primarily a student of species and characterized only fifteen genera. Ashmead's early work on the Hymenoptera was his hobby but in later years it became his profession. Cresson's work up to 1868 was done in connection with his curatorial duties, while after that date it was a hobby which could be followed only at night after a full day's labor in other fields.

It would be very difficult indeed to attempt to state which of these workers should have the greater renown or which of them will have exerted the more lasting influence on the taxonomy of American Hymenoptera. The work of the two was along very different lines.

Although Cresson studied practically all the families of American Hymenoptera, he described many more species belonging to the family Ichneumonidae than in any other group. In the family Apidae, which is next in the number of forms described, he characterized 531 species and five genera. All told, Cresson described 2,737 species, and many of these came from North America north of Mexico. However, his treatment of the Hymenoptera of Cuba must not be overlooked, as it will stand for many years as a monument to his careful researches.

While Cresson described species in practically all the groups, he showed a very decided preference for those of large size and hence characterized comparatively few forms belonging to the important superfamilies Serphoidea (or Proctotrupidae, as he would have called it) and Chalcidoidea (then the family Chalcididae). Neither Cresson nor Ashmead devoted much time to the study of the ants.

All of Cresson's papers show the orderly way in which he worked and how well he knew the literature of his predecessors and coworkers; and practically all of them give references to the literature of all of the species occurring within the limits of his paper. His paper on the Hymenoptera of Texas is an excellent example of his cataloguing ability.

Cresson's descriptions are, considering the time and conditions under which he worked, extremely satisfactory. They set forth the differences known to exist between the species known to him and convey a definite picture of the specimens before him. In most of his work he described the species without giving synoptic keys. One marked exception to this was his paper on the old genus *Ichneumon* (*Amblyteles* according to present authors), which is preceded by a synopsis based on color but which serves very satisfactorily to distinguish the species known at that time.

Undoubtedly the master publication of Cresson was his "Synopsis of Hymenoptera of America North of Mexico," published in 1887. This paper was preceded by a short chapter which summarizes, describes and illustrates important structural char-

acters used in the classification. This brief chapter is so clearly and carefully written that it enables beginning students to grasp quickly the necessary terminology. I can well remember the aid it was to me as a beginner, and I remember with considerable pleasure the few hours I spent in learning the terminology of the wing veins. It served as my first text on the classification of Hymenoptera. While Cresson states in the introduction that the Synopsis is compiled largely from the writings of others, an examination of it shows very clearly that it is not entirely a compilation. Certain large parts of it are directly compiled from the work of others, but in the groups with which Cresson was most familiar there is considerable new information. The classification of Ichneumonidae follows that of Holmgren but contains many valuable supplementary characters which Cresson observed in the material he studied. The key to the genera of Pompilidae (Psammocharidae, as it is now called) is largely original, and the same can be said for the synoptic differences given for the genera of the families Sphecidae, Philanthidae and Masaridae. The classification of the genera of the bees follows rather closely that of Saunders, but contains valuable information from Westwood's writings as well as placing the new genera described by the American workers. This synopsis is followed by a catalogue of the species of Hymenoptera known to occur north of Mexico, and is the very latest check list to the Hymenoptera of North America. To a large extent it has been superseded by the accurate catalogues prepared and published by Dalla Torre, but for a work to stand as a hand-book and beginning text from the year 1887 until today certainly speaks well for it and shows that it must have been carefully and accurately compiled.

In the sawflies Cresson did little more than prepare a catalogue and describe new species. In this work he followed the generic classification used by his coworker Edward Norton. His catalogue of the sawflies of North America, together with his descriptions of 164 species, bound together with the Synopsis of American Sawflies published by Norton, forms the one absolutely necessary work to all students of American sawflies. These three papers were published under one cover in 1880 and today stand as the only single volume which treats of the chalastogastrous Hymenoptera of the Nearctic region.

As a man Cresson was modest, courteous, coöperative, just and conscientious, and because of these qualities was able to work in full coöperation with all students of Hymenoptera throughout the world. Considering the fact that he worked on insects only in his spare time and under certain handicaps, one wonders that he did so much so well.

Cresson's Work on the Parasitic Hymenoptera

BY L. O. HOWARD

Chief of the Bureau of Entomology, United States Department of Agriculture

As I am not and never was an all-round Hymenopterist, I am not competent to give an expert opinion on Mr. Cresson's work. I can only tell that his work on the parasitic Hymenoptera was of great use to me and of great use to all of my co-workers forty years or more ago. I used constantly to study his papers published by the Society [in Philadelphia], and when he finally published his "Synopsis of the Hymenoptera of America North of Mexico" (1887) we all had it bound immediately, and it was in almost daily use by all of us. He was undoubtedly the first, most prolific and soundest writer on the order in America.

I met him first in the early eighties, in Philadelphia, and was greatly impressed by the delightful reception he gave me. He placed his collections entirely at my disposal and sat with me on a busy afternoon explaining labels and urging me to continue taxonomic work in the Chalcididae (now Chalcidoidea) and the Proctotrypidae (now Proctotrypoidea). I felt very highly complimented when he asked me to contribute the chapters on these two groups in his great "Synopsis." We looked upon him at that time as a master, and undoubtedly he did work of very great importance in helping to establish a sound school of workers in entomological taxonomy in the United States.

As I look through my library of books and papers on the Hymenoptera, I find among other things a volume which must surely run to nearly two thousand pages and which is composed entirely of papers by Cresson. Practically all of them were published either by the Philadelphia Academy of Natural Sciences in its Proceedings or in the Transactions of the Entomological Society. This volume was bound in December, 1885; and of course I have other, separate, pamphlets of a monographic character.

Cresson's Work on the Ichneumonoidea

BY H. L. VIERECK

The work of the late Ezra T. Cresson on the Ichneumonoidea is the foundation for all the work on North American Ichneumonoidea that is being done now. His reliance on recognition characters will no doubt influence students now and in the future to give such characters the attention they deserve. The influence he exerted in the Ichneumonoidea he also exerted in the Hymenoptera in general and through his painstaking efforts he has endeared himself to all who will now and subsequently investigate the North American Hymenoptera. . . . In extenso I would add that Mr. Cresson undoubtedly was influenced in his classification of the Ichneumonoidea by the work of Gravenhorst, as he did not recognize genera that were segregated from Gravenhorst's genera by Holmgren and Foerster. I know that he was dissatisfied with Foerster's classification and in that view he was not alone.

E. T. Cresson's Work on Bees

BY T. D. A. COCKERELL

University of Colorado

The bees of North America are still imperfectly known. If we take the whole continent down to Panama, and including the West Indies, we find that eight names of species are credited to Linnaeus, twenty-seven to Fabricius, two to Olivier, two to DeGeer, two to Drury, two to Latreille. In the eighteenth century our bees were only described incidently, along with other insects. The Rev. W. Kirby, who described the insects of the Fauna Boreali-Americana (1837) is credited with thirteen species. His French contemporary Lepelletier de Saint-Fargeau, representing a more advanced stage of the subject, made known twenty-four of our species. In the meanwhile Thomas Say was actively at work in this country and we are indebted to him for the names of as many as thirty-nine bees. About the middle of the last century American bees engaged the attention of Frederick Smith of the British Museum, whose last work was published after his death, in 1879. Smith's descriptions gave us 242 additions to our list, mostly from the Eastern and Southern

states, but including several from Mexico and some from the Pacific region. There were also species from the West Indies, including a remarkable series of *Megachile* from Santo Domingo. Smith, at the end of his life, actually began the description of the bees for the "Biologia Centrali-Americana" of Godman and Salvin, using the first fruits of the Central American explorations. The great collection which was eventually gathered together, destined for this work, remains today in the British Museum, unrecorded save for a few species taken up incidentally.

If we distinguish periods in our history of American bees, we may speak in general terms of the period of Fabricius, the period of Say, the period of Smith, and then, far surpassing all previous ones in richness of accomplishment, the period of Cresson. E. T. Cresson began to describe North American Hymenoptera in 1861, but his most important work on bees belongs to the year 1878, the last year of Smith's life. The total number of names of bees proposed by Cresson is 601; several years ago I estimated that these represented 541 valid species. The descriptions are good, and among the comparatively few names to be suppressed, several are homonyms, and involve no mistakes in differentiation or diagnosis. The types are nearly all at the Philadelphia Academy, where they can be examined by students. It is of some interest to catalogue the names according to the type localities. The largest number of species (108) is from Colorado, but Texas, with 106, runs it close.

We know to-day from Colorado about 785 species, and I find in the list 168 Cressonian names, some representing varieties rather than species. That this far exceeds the number described by Cresson for Colorado is of course explained by the discovery in our state of numerous species he described from other parts of the continent. Next to Colorado comes, Mexico, with ninety-one Cresson species; then California with fifty-two, Nevada with forty-eight, Cuba with forty-one and Georgia with twenty-nine. After this the numbers are small: British America sixteen, New York fourteen, Illinois thirteen, Pennsylvania and Connecticut each eleven, New Mexico nine, Kansas seven, Massachusetts and Utah each six; Alaska, Porto Rico and Costa Rica each three; Oregon, Virginia, West Virginia, New Jersey, Delaware, Maine, Florida, each two; Arizona, Dakota, District of Columbia, Missouri, North Carolina and Guadalupe Islands (Lower

California), each one. It will be seen that the great southwestern fauna, of New Mexico, Arizona and adjacent regions, was hardly known at all to Cresson. The fauna of the southeastern States, especially that of Florida, is still urgently in need of investigation. The Pacific coast region is far richer in endemic forms than could have been imagined in Cresson's time, a consequence of the extremely varied and peculiar flora. It may be found, when our bees are completely known, that Cresson described about one-tenth of the existing species; but his place in the history of the science is very much more important than such figures would imply. Very many of the dominant, widespread or conspicuous species are Cressonian, and half a day's collecting almost anywhere will produce one or more forms which he named. We of a later generation look back on Cresson's labors with gratitude and respect. We regret the rarity of tables but this defect may still be made good from the type specimens, and has been to some degree. More unfortunate is the lack, in the vast majority of cases, of precise localities. The collectors who furnished the specimens in those days imagined Mexico, Colorado, Texas or California to be quite precise enough; to-day it is scandalous to publish a species with no better data, unless it is explained that nothing more can be learned. It is certain that Cresson gave all the information which the labels afforded, but it may still be possible in some cases to find out where Sumichrast, Morrison, Henry Edwards, Ridings and others actually went. In the case of the Texas collections, we gather from the introduction to "Hymenoptera Texana" that Belfrage collected in Bosque County, Boll in Dallas County, and Heiligbrodt in Travis and Bostrop Counties. May we assume that this applies also to the later recorded species for these collectors? The whole series belongs essentially to the humid Lower Austral and the species may be expected to range eastward rather than westward.

E. T. Cresson and the Family Mutillidae

BY DR. J. CHESTER BRADLEY

Department of Entomology, Cornell University, Ithaca, N. Y.

When in the late fifties, inspired by the traditions of a group of older naturalists of his community, Ezra Townsend Cresson,

a young Philadelphian, commenced a pioneer study of the almost unknown hymenopterous fauna of a continent that was still in a very real sense the New World, only sixteen North American species of Mutillidae had been described, eleven of the sixteen by Europeans.

The beautiful and conspicuous *Mutilla occidentalis* was known to Linnaeus, and by him described. In the closing years of the eighteenth century and early ones of the nineteenth, Fabricius described three, of which only one, *ferrugata*, has since been recognized. Lepeletier in 1845, twenty years before the appearance of Cresson's first description, had described the eastern *fenestrata*, *pennsylvanica* and *rufa*. Smith, cataloging in 1857 the Hymenoptera of The British Museum, had added only three more, *frigida* (not since recognized) and the common eastern forms, *simillima* and *dubitata;* and finally Radowzkowski, through Siberian connections, had obtained a single species from California, to which in 1861 he applied the name *californica*. No one living on this side of the Atlantic had ventured to describe any species, except Thomas Say, who had made known three common eastern forms, *quadriguttata*, *hexagona*, *scrupea*, and two others which have since remained obscure.

Thus it will be seen, that when in 1865 the young Cresson first published anything about Mutillidae, only a single species was known from West of the Mississippi River. Indeed the entire insect fauna of the western territories was still almost totally unknown. Mr. Cresson published first the descriptions of four Cuban species, forming part of his voluminous treatment of the Hymenoptera of Cuba, appearing in 1865. With this one exception and until after the close of the century, such further work as he did on the family was entirely by way of making known the rich material that came to his hands from the western United States and Mexico. In his Hymenoptera of Colorado, 1865, he described nineteen species, and this has remained his most comprehensive contribution to our knowledge of the North American members of the family. Naturally he described in it some species that are now known to be abundant western forms, and we can well say that it formed the foundation of our knowledge of that fauna. Later in the same year he published "Descriptions of some Mutilla from California" which dealt with five forms collected in Baja California.

After an interval of seven years, Mr. Cresson in his "Hymenoptera Texana" listed the Texan species, but described no new Mutillidae. In 1875 ("Descriptions of new species of Mutilla") he described five more species from California, one from Oregon, two from Texas and one from Nevada. In the Wheeler Survey report, the same year, he described *Mutilla nitida* (now excluded from the family Mutillidae) and that was the last North American Mutillid that he ever described.

It is interesting to reflect, that although a considerable number of undescribed Mutillidae were common insects on the New Jersey side of the Delaware, and could hardly have been altogether absent from his own dooryard, Mr. Cresson never described a single species from east of the Mississippi River. Yet it is not surprising that the opportunity to acquire specimens from the far West, to which may have been added the glamour of far away pioneer lands, should have led him to faunistic and descriptive studies of that territory, to the exclusion even of that which was closer at hand. As a matter of fact until after the end of the century he never particularly turned his attention to Mutillidae at all, at least not to the extent of preparing a synoptic study of the group; but that was probably with the definite intent of leaving a free field to his coworker, Charles Blake, who had at that time such work well in hand.

It was not until he was already an elderly man that Mr. Cresson undertook an elaborate piece of research exclusively upon Mutillidae. Part of the extensive collections of Hymenoptera made by Herbert H. Smith through many years residence in Brazil had been placed in the hands of his son George for study and the Mutillidae were undertaken by his father. The result, published under the modest title of "Descriptions of some Mutilla from Brazil" was his last descriptive paper. In it he described approximately one hundred new species, and published keys to the species that he had studied.

In brief, then, Mr. Cresson's work on Mutillidae has been faunistic and descriptive pioneer work. Even in his last and most extensive paper just mentioned, on the Brazilian forms, he did not discuss species not represented in the collection he was studying. Critical revisionary or monographic work on the family, the next necessary step after the pioneering, has been left for succeeding generations.

Notes

(1) Poulton, *Proceedings of the 2nd International Congress of Entomology*, pp. 21, 154, 155.

(2) J. G. Morris, *Amer. Jour. Sci.*, (2) I, p. 27, 1846; *Can. Ent.*. XIII, p. 186, 1881.

(3) Cresson Family in "Colonial Families of Philadelphia," John W. Jordan, LL.D., Editor. New York, Chicago. The Lewis Publishing Co., 1911. 2 volumes, paged continuously. Vol. II, pp. 945–959.

(4) Caleb Cresson left a diary which was published by his greatgrandson under the following title: Diary of Caleb Cresson 1791–1792. Printed from his Original Manuscripts, for Family Distribution, By Ezra Townsend Cresson and Charles Caleb Cresson. Philadelphia: 1877. 214 pp., 2 photographs.

(5) For Warder Cresson see Elfrida D Cowan s "Warder Cresson: A Pioneer in Palestine" in the *The Maccabaean* New York, XXXI, no. 2, pp. 41–43, Feby., 1918. For Elizabeth Townsend, see J. C. Martindale's History of Townships Byberry and Moreland, in Philadelphia, Pa. New Ed. Philadelphia, George W. Jacobs & Co. n. d. Warder Cresson was the author of the following works:

"Babylon the Great is Falling! The Morning Star, or Light from on high. Written in defence of the Rights of the Poor and Oppressed. Philadelphia; Printed by Garden and Thompson. 1830." [Author's name *not* on titlepage but at end of preface on reverse side of title page: "Warder Cresson. Written at his residence, in Gwynedd, 10th month 1829." Pp. 68.]

"Letter to a Universalist." 3 pp. no title page, no date.

"Jerusalem the Centre and Joy of the Whole Earth, and the Jew the Recipient of the Glory of God. By Warder Cresson, United States Consul at Jerusalem. Second Edition. London: J. Nisbet and Co., Berners Street; B. Wertheim, Aldine Chambers, Paternoster Row. M.DCCC.XLIV." [17 × 10.5 cmm. Pp. xvi, 144 + 2 unnumbered pages at the end. Last page (unnumbered) contains following advertisements:]

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"Persons desirous of becoming subscribers for this periodical, are requested to forward their names to J. Nisbet and Co., Berners Street, or B. Wertheim, Aldine Chambers, Paternoster Row, London; Mr. Alexander Forbes Porter, next door to the corner of Schuylkill 5th and Spruce Sts., Philadelphia; or to Mr. Warder Cresson, Jerusalem."

"The Key of David. David the True Messiah, or The Annointed of the God of Jacob. The Two Women who came to King Solomon Were designed, in the greatest depth of Wisdom, to represent The true and false churches, and the living and dead child, or Messiah. Also, Reasons for becoming a Jew; with a revision of the late lawsuit for lunacy on that account. Together with an appendix. Philadelphia: Sold by all the Principal Booksellers. 5612 Entered according to the Act of Con ress, in the year 1852 by Warder Cresson in the Office of the Clerk of the District Court of the U.S. in and for the Eastern District of Pennsylvania." pp. iv, 13–344, [no pp. 1–12, nor are such referred to in the table of contents. Pp. 13, 202–244, "Lunacy case, or the Great Lawsuit for becoming a Jew," and pp. 329–331, "Appendix F," contain autobiographical material.]

(6) The writer has a note of April 30th, 1914, from the late Dr. Henry Skinner: "Mr. E. T. Cresson went as far as the first division of the Clevenger Grammar School, Philadelphia. Perhaps it was first division grammar of the Clevenger School." Dr. Skinner probably got this information verbally, direct from Cresson himself. An examination of the twenty-ninth and thirty-seventh Annual Reports of the Controllers of Public Schools of the First School District of Pennsylvania for the years 1847 and 1855 respectively, gives no school under the name of the Clevenger School, but both state that Wm. S. Cleavenger was Principal of the Locust Street School, corner of 12th and Locust Sts. Cresson's memory, probably and very naturally, substituted the name of the principal teacher for that of the school.

(7) The location of this house is exactly specified in Cresson's History of the American Entomological Society, p. 13: as "728 Erie street, first door above Fitzwater, west side, between Tenth and Eleventh streets." What appears to have been the house in which this meeting occurred is still (August 31, 1927) standing. It is the southernmost of a row on the west side of South Warnock Street, which row reaches northward almost to Bainbridge Street. These houses are three story, brick with white marble lintels and window sills. The deeds recording the successive transfers to Elizabeth T. Cresson, mother of Ezra T. Cresson, on February 28, 1855, and from her (May 4, 1865) to the next owner and on to August 3, 1896, as well as the notice of a Sheriff's sale, December 3, 1897, all mention a "three story brick messuage or tenement" or "house."

(8) For an obituary notice of James Ridings see *Trans. Amer. Ent. Soc.*, VIII, Proceedings, p. xv.

(9) A small pamphlet of 7 pages, in a cover entitled "Feldman Collecting Social 1887–1907," exists and contains a brief history, lists and a group portrait of members and separate portraits of Henry Feldman and J. H. B. Bland. Both of the latter have been published also in *Ent. News*, vol. 7, pl. 5, and vol. 23, pl. 5.

(10) Miss (now Dr.) Helen D. King, in her biography of Cope says: "When a boy Cope made a collection of insects and studied their habits, but he did not continue this work or take up any other branch of invertebrate zoology. His only contribution to this department of science are brief descriptions of lower forms, principally myriopods, found in different cave formations in the United States." (*Amer. Geologist*, XXIII, p. 8, Jan., 1899). In Miss King's bibliography of Cope's writings are the following entomological titles: "On the Habits of a Tipulideous larva," *Proc. Acad. Nat. Sci. Phila.*, 1867. "Synopsis of the Extinct Mammalia of the Cave Formations of the United States, with Observations on Some Myriopods Found in and Near the Same and on Some Extinct Mammals of the Caves of Anguilla, W.I., and of other Localities," *Proc. Amer. Phil. Soc.*, XI, 1869. "On Some new and little known Myriapoda from the Southern Alleghenies." *Trans. Amer. Ent. Soc.*, III, 65–67, May, 1870. "Heredity in the Social Colonies of Hymenoptera," *Proc. Acad. Nat. Sci. Phila.*, 1893.

(11) "A History of the American Entomological Society Philadelphia 1859–1909" . . . by E. T. Cresson, p. 22.

(12) *Entom. News*, XIV, p. 215, Sept. 1903.

(13) "Record of My Life Work in Entomology." Cambridge, Mass., 1903, pp. 41–42.

(14) Proc. Ent. Soc. Phila., I, p. 33.

(15) Proc. Ent. Soc. Phila., I, p. 26.

(16) Proc. Ent. Soc. Phila., I, p. 32.

(17) Proc. Ent. Soc. Phila., II, pp. 164–5.

(18) *Cf.* Proc. Ent. Soc. Phila., III, pp. 437, 672, 673, 693; IV, p. 1.

(19) A biography of Wilson is in *Proc. Ent. Soc. Phila.*, V, appendix.

(20) *Hist. Amer. Ent. Soc.*, p. 23.

(21) Joseph Albert Lintner, 1822–1898. Dr. E. P. Felt, his successor at Albany, published a "Memorial of his Life and Entomologic Work" in *Bull. N. Y. State Mus.*, vol. 5, no. 4, May 1899 (Suppl. to 14th Rept. State Entomologist), with portrait and bibliography. Dr. Felt kindly lent to the writer a package of 29 letters and 16 post cards from E. T. Cresson to Lintner dating from Oct. 14, 1862, to Feb. 5, 1897. A number of these have been reproduced in this memoir. We have not found Lintner's letters to Cresson, nor those of Belfrage, Howard, Zabriskie and others to whom Cresson wrote the letters quoted in this biography.

(22) Nolan, E. J. "A Short History of the Academy of Natural Sciences of Philadelphia, in Founders' Week Memorial Volume," edited by Frederick P. Henry, Phila., 1909, p. 168 (p. 20 of the separate copy).

(23) See *The Practical Entomologist*, numbers for Dec. 25, 1865, March 26, 1866, Oct. 1866, Aug.–Sept., 1867.

(24) The list of officers of the Society given on page 50 of Cresson's History states that he was Corresponding secretary 1859–1874 and curator 1866–1874. The "Thanks" document reproduced in our text shows the date 1874 to be too late. The minutes of the Society after Dec. 14, 1868, and until Apr. 14, 1873, seem to be lost, but at the annual election of officers in Dec., 1873, Cresson's name does not appear as having been elected to either of these positions.

(25) Cresson's entomological writings are listed in Memoirs Amer. Ent. Soc., No. 1, pp. 135–140, 1916. Two have been omitted from this list, viz.: 1880. "Notice of three new Hymenopterous Parasites," *American Entomologist*, III, p. 24 and 1891, "Description of Pimpla grapholithae n.sp." *Ent. News*, I, pp. 50–51.

(26) *Proc. Ent. Soc. Phila.*, IV, p. 1.

(27) *Trans. Amer. Ent. Soc.*, IV, p. 153.

(28) For permission to copy and use the letters of Cresson to Belfrage, the writer is indebted to Mr. S. A. Rohwer of the U. S. National Museum.

(29) The "list of species" referred to is preserved with this letter in the U.S.N.M. and is headed "Desiderata to collection of Am. Ent. Soc. In the collection of G. W. Belfrage Esq., Clifton, Texas." It comprises names and [Belfrage's ?] numbers of 78 species of 15 families as recognized in Cresson's own paper, "The Cresson Types of Hymenoptera" (*Mem. Amer. Ent. Soc.*, No. 1, pp. 1–134, 1916). 30 of these species are Ichneumonidae and 15 Braconidae. On comparing these names with the "Types" paper, the great majority of the 78 species are there recorded as "Type in Belfrage Collection, U.S.N.M", but a few are in the collection of the Am. Ent. Soc. as "type returned by Belfrage," some are "not found" and some not mentioned, as being species described by others.

(30) *Trans. Amer. Ent. Soc.*, ii, p. 1, 1868

(31) The "Synopsis" was published as a "Supplementary Volume" of the Trans. Amer. Ent. Soc., without a volume number.

(32) Hearty thanks of the writer are due to Dr. L. O. Howard for the loan of 37 letters and 10 post cards to him from Cresson, dating from Dec. 3, 1885 to Nov. 8, 1888, the great majority in 1886 and 1887. Most of these are quoted in this memoir. Mr. R. A. Cushman, of the U. S. National Museum, kindly lent me a letter from Cresson to the Rev. J. L. Zabriskie, of Feb. 9, 1886, relating to the "Synopsis," but as this letter is much like the first half of his letter to Dr. Howard of Dec. 3, 1885, I have not used it.

(33) William Hampton Patton, hymenopterist, 1853–1918. For a biography, portrait and bibliography see Britton and Howard, *Ent. News*, XXXII, pp. 33–40, 1921, containing a quotation from a letter by E. T. Cresson concerning a collection of Andrenidae belonging to the American Entomological Society.

(34) L'Abbé Leon Provancher, of the Province of Quebec, 1820–1892, editor and proprietor of *Le Naturaliste Canadien*. A biographical notice by by l'Abbé Huard was published in installments in Vols. 21–26 of the same journal.

(35) William Harris Ashmead, 1855–1908. Obituary notice and portrait. *Ent. News*, XIX, p. 397, pl. XVI.

(36) Charles Valentine Riley, 1843–1895, Entomologist to the United States Dept. of Agriculture 1878–9, 1880–1894. Obituary notice and portrait. *Proc. Ent. Soc. Washington*, III, pp. 293–298.

(37) Homer Franklin Bassett, 1826–1902. Obituary notice and portrait in *Ent. News*, XIII, pp. 203–205, pl. X, 1902.

(38) *Proc. Ent. Soc. Washington*, I, p. 96.
(39) A. D. Imms, "A General Textbook of Entomology," New York, E. P. Dutton & Co., no date but published in 1925; p. 529.
(40) *Trans. Amer. Ent. Soc.*, XXVIII, pp. 1–82.
(41) *Memoirs, Amer. Ent. Soc.* No. 1, pp. 1–141.
(42) Henshaw, *Trans. Amer. Ent. Soc.*, XXV. p. lxvii, 1898.
(43) Scudder, *Trans. Amer. Ent. Soc.*, XI, p. xvii, 1884. *Nat'l Acad. Sci. Biog. Mem.*, II, p. 280.
(44) Henshaw, *Trans. Amer. Ent. Soc.*, XXV. pp. xxv–xxxvii, 1898.
(45) *Trans. Amer. Ent. Soc.*, XVI, Proceed. Ent. Sect., p. xvii.
(46) Skinner, *Ent. News*, VII, p. 306, 1896.
(47) Skinner, Proc. Acad. Nat. Sci. Phila., 1901, p. 771.
(48) Hist. Amer. Ent. Soc., p. 32.
(49) *Trans. Amer. Ent. Soc.*, VII, Proceedings Ent. Sect. Acad. Nat. Sci.
(50) *Ent. News*, XXXVI, pp. 159–160, 1925.
(51) *Ent. News*, XXXVI, p. 255, 1925.
(52) His letter of notification is as follows:

"INTERNATIONAL CONGRESS OF ENTOMOLOGY

c/o Entomological Society of London.... *February 6th, 1913*

re Second International Congress of Entomology, Oxford, 1912.

DEAR SIR,

I have pleasure in informing you that at the Second International Congress at Oxford you were unimously [*sic*] nominated Honorary Member of the International Entomological Congresses.

This entitles you to all the privileges and same rights as a Life-Membership and you will receive the publications free of charge.

I am, Dear Sir,
Yours faithfully,
For the EXECUTIVE COMMITTEE
(signed) MALCOLM BURR,
General Secretary.

E. T. CRESSON ESQ.,
Philadelphia."

On the margin is a notation in E. T. Cresson's handwriting "Ack. 3–3'13." By some clerical error, in the printed *Proceedings of the Second International Congress of Entomology*, pp. 124 and 160, his name is given as G. B. Cresson (the name of his oldest son). The error is continued in the *Verhandlungen* of the Third Congress, p. 35, which mentions the death of G. B. Cresson, an "Ehrenmitglied."

(53) An obituary of G. B. Cresson, 1859–1919, is in *Ent. News*, XXXI, pp. 29–30, 1920.
(54) See E. T. Cresson, Jr., *Trans. Amer. Ent. Soc.*, XLVIII, pp. 197–203, 1922, for a list of Bassett's types in this collection.

(55) *Trans. Amer. Ent. Soc.*, I, pp. 375–388.
(56) *Proc. Ent. Soc. Phila.*, III, p. 397.
(57) *Proc. Ent. Soc. Phila.*, V, pp. 186–187.
(58) For Leidy's expressions on evolution, see his "Fauna and Flora within Living Animals" (*Smithsonian Contrib.* V, 1853, pp. 9–11) quoted by Chapman in his memoir of Leidy (*Proc. Acad. Nat. Sci.* 1891, pp. 353–4) with the comment: "he rarely indulged in such speculations"; his "Address on Evolution and the Pathological Importance of Lower Forms of Life, Delivered before the Graduating Class of the Medical Department of the University of Pennsylvania, May 1, 1886" (*Therapeutic Gazette*, Detroit, June 15, 1866); a few of the opening sentences are quoted by F. H. Garrison in his article on Leidy (*Alumni Register, Univ. Penna.* XXI, p. 568, 1919); also Leidy's "Remarks on the Nature of Organic Species" (*Trans. Wagner Inst. Sci.*, II, pp. 51–53, 1889) and H. S. Jennings' "Leidy's Zoological Work" (*Scient. Monthly*, XVIII, pp. 427–432, 1924). For LeConte, see his Presidential Address to the Amer. Ass. Adv. Sci. (*Amer. Nat.*, IX, especially pp. 485 and 496, 1875); also Scudder's "Biographic Sketch" (*Trans. Amer. Ent. Soc.* XI, p. xviii; *National Acad. Sci. Biog. Mem.*, II, p. 293). For Horn, see the present writer's "Biographical Notice," (*Trans. Amer. Ent. Soc.*, XXV, pp. xv–xviii, 1898). Cope's "Origin of the Fittest," 1887, and "Primary Factors of Organic Evolution," 1896, are well known.

Two brief obituary notices of Ezra Townsend Cresson have been previously published by the present writer, (*Ent. News*, XXXVII, pp. 161–163, with portrait, 1926; *Science*, LXIV, pp. 8–9, July 2, 1926.)

The large portrait accompanying this memoir was taken December, 1895.

The present memoir has been read by E. T. Cresson, Jr., J. A. G. Rehn, and Wm. J. Fox, and has had the benefit of their criticism, for which the writer's thanks are gratefully expressed.

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